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Wastage in Australian Fruit Exported to England.

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The following report has been made available as the result of the kindness of Sir William Hardy, Director of the Food Investigation Board of the British Department of Scientific Research. The report was furnished to the Council with the indication that it could be published or used in any other way that seemed appropriate. Copies have already been sent to the various State Departments of Agriculture and to the Department of Markets.—ED.

1. Introduction.
2. Apples.
3. Pears.
4. Grapes.
5. The Prevention of Wastage.

1. Introduction.

A scientific survey of the condition of Australian fruit in the English markets was initiated by the Food Investigation Board in 1926 in order to identify the chief types of wastage, and to obtain a rough measure of their relative severity.

The findings of this survey were confirmed and rendered more precise by the quantitative data for wastage obtained by the Empire Marketing Board in 1927 as a result of a systematic examination of shipments of fruit on arrival at the Docks, and it is accordingly possible to give an account of the wastage in Australian fruit with considerable confidence in its accuracy.

The results of the Dock examinations conducted by the Empire Marketing Board have been presented in a report issued by the Board —" Special Report No. 3. Report on Fruit Investigation during the Australian and New Zealand Season, 1927 "—but the most important quantitative results of the work are included here to give additional significance to the general statements, which alone could be made on the basis of the Food Investigation Board survey. For further details of the Dock examinations and an indication of the reliability of the figures reference should be made to the above Report.

2. Apples.

Details of Survey.

Wastage has been chiefly due to two diseases, bitter-pit and internal breakdown, and of these bitter-pit has caused the more serious losses in fruit on arrival at the Docks.

The actual figures for wastage due to these two diseases for the various varieties throughout the season are given in Table 1.

TABLE 1.—Percentage wastage for different varieties due to Bitter-pit and Internal Breakdown in all samples examined during the 1927 season.*

Tasmania.			Western Australia.		
Variety.	% Bitter Pit.	% Internal Breakdown.	Variety.	% Bitter Pit.	% Internal Breakdown.
Adam's Pearmain	2.0	2.0	Cleopatra ..	18.0	0.2
Alfriston ..	2.0	2.0	Dunn's Seedling	0.5	0.0
Cleopatra ..	10.0	0.2	Granny Smith ..	7.0	0.0
Cox's Orange Pippin	21.0	4.0	Jonathan ..	4.0	5.0
Dunn's Seedling ..	7.0	2.0	Rokewood ..	1.0	0.0
Jonathan ..	1.0	3.0	Rome Beauty ..	2.0	0.0
King Pippin ..	0.0	2.0			
Ribston Pippin ..	9.0	3.0			
Scarlet Pearmain..	1.0	0.3			
Sturmer Pippin ..	9.0	0.1			

It will be seen that the occurrence of bitter-pit has been of significant extent in Cox's Orange Pippins, Cleopatras, Ribston, and Sturmer Pippins from Tasmania, and in Cleopatras from Western Australia.

Internal breakdown has been less extensive in fruit on arrival at the Docks than bitter-pit, but this disease may actually be responsible for equally serious, if not greater, wastage since the further wastage during the period of distribution and consumption appears to be unexpectedly rapid. Examples of this deterioration are given in the next section. At this stage it will suffice to state that the varieties most susceptible to internal breakdown are Jonathans, from both Tasmania and Western Australia, and Cox's Orange Pippins, and Ribstor Pippins from Tasmania.

The Dock examination data for successive shipments throughout the season are on the whole in agreement with the accepted generalizations that bitter-pit is much more extensive in the early shipments of each variety, and that both bitter-pit and internal breakdown are more severe in the larger apples of each variety. There is also some indication that internal breakdown increases in the later shipments of the susceptible varieties, and is more liable to occur in apples which are yellow in colour on arrival than in fruit which is less ripe.

The wastage due to fungal rotting is relatively small—under 1 per cent. for all varieties throughout the season—and appears to be due mainly to mould attack following accidental skin injuries due to bruising, &c.

Jonathan spot was observed in both Western Australian and Tasmanian Jonathans, but the proportion was significant (9 per cent.) only in the case of the former.

In addition to the above types of deterioration, severe freezing was found in several hundred cases in two shipments, and in one shipment, brown heart was present.

* These figures were obtained in the routine examination of shipments of fruit on arrival at the Docks conducted by the Empire Marketing Board. A full account of this work is given in Special Report No. 3 of the Empire Marketing Board.

Wastage During Period of Distribution and Consumption.

The inaccurate nature of the market salesman's examinations and the shortness of the period for which fruit normally remains in the warehouse make it unwise to attach much importance to market reports of rapid wastage, following unloading. Nevertheless it should be mentioned that Tasmanian Cox's Orange and Ribston Pippins and Western Australian Jonathan apples were often reported as showing very rapid wastage due to internal breakdown. This wastage was particularly noticeable in large apples.

Actual observations of the rate of development of internal breakdown were made upon three boxes—one of Cox's Orange Pippins and two of Ribston Pippins. The boxes were selected as showing a small proportion of breakdown on arrival in the market. The figures for development of internal breakdown in these cases are given in Tables 2, 3, and 4, and indicate a surprisingly rapid rate of deterioration. If such deterioration is typical of a significant proportion of the marks of these varieties, then the total wastage due to internal breakdown must be heavy.

It is clearly most desirable that further information on this point should be obtained, and it is accordingly proposed to adopt the method of keeping boxes under observation in the laboratory in order to make a fairly exhaustive study, during the coming season, of the deterioration following unloading in the varieties susceptible to breakdown.

Table 2. 2½″ Cox's Orange Pippin, Collinsdale.—

Days from discharge	5	10	18	30
Internal breakdown	0.7%	12.8%	25.0%	33.8%

Table 3. 2½″ Ribston Pippin, Latrobe.—

Days from discharge	3	9	18
Internal breakdown	4.0%	20.5%	38.5%

Table 4. 2½″ Ribston Pippin, Tasmania.—

Days from discharge	6	19
Internal breakdown	2.5%	16.5%

In the market, it is often stated that bitter-pit develops rapidly after the apples reach the market. From experimental work on this point, however, this statement appears to be correct only in the sense that the surface pitting becomes more prominent, but not in its suggestion that surface pitting appears in fruit which is free from pitting on arrival at the market. Thus, in Tasmanian Cleopatra apples kept in the laboratory no fresh occurrence of bitter-pit in sound apples was noted, even after several weeks, but the affected apples showed an increase in the severity of the pitting.

Australian apples are accordingly not likely to acquire a reputation for rapid deterioration because of the development of bitter-pit after leaving the ship. This reputation may, however, attach with some justice to certain varieties, if the development of internal breakdown in apples, apparently sound when unloaded, is as rapid as would appear to have been the case during the 1927 season.

Significance of Results of Survey.

From the above account of wastage in Australian apples it will be evident that the reduction of the amount of wastage in the fruit on its arrival at the market depends almost entirely on ability to control the development of the two diseases, bitter-pit and internal breakdown.

Bitter-pit.

It has long been known that bitter-pit is much more extensive in early than in later shipments, but according to the information available here, experimental evidence of the relation between development of bitter-pit and maturity of picking is still inadequate. Similar uncertainty apparently prevails with regard to the effect of the temperature of storage, or of delay before storage on the development of bitter-pit.

In view of the great importance of such knowledge to the Australian apple industry, and the fact that this knowledge could be readily obtained by relatively simple experimentation in Australia (the irregularity of the occurrence of the disease in England renders it impossible to carry out investigational work here), it is very striking that the published work on bitter-pit in Australia is so limited in extent, and so inconclusive in character.

Internal Breakdown.

The fact that internal breakdown is responsible for considerable losses in certain varieties on arrival at the Dock, and that the further wastage due to this type of deterioration after unloading may be of very serious extent, appears not to have been fully realized hitherto. This position is undoubtedly largely attributable to the salesmen's inability to diagnose accurately any type of deterioration other than bitter-pit. A study of the salesmen's report on wasty samples of fruit has shown that the condition of internal breakdown is either described as "chilled," "frozen," or "frosted," or antithetically as "over-ripe and wasty." This latter description is often applied to apples which are green in colour, and are definitely not over-ripe, but subject to internal breakdown.

As a consequence of this inaccurate identification* of wastage, little reliable information is available of the factors determining the development of internal breakdown in Australian apples. The utility of such knowledge may be shown by a brief consideration of internal breakdown as it is known in English and American apples. In these apples there appear to be two distinct types of internal breakdown—

(i) *Low Temperature Type.*—This is a disease of cold storage developing earlier in storage at 34 degrees than at 38 degrees F.; the onset in storage is little affected by maturity at picking. This type of breakdown has been observed in English Bramley's, Lanes, &c., and in the Californian Yellow Newtown.

(ii) *Jonathan Type.*—This is a disease which occurs at all temperatures. It may occur on the tree, and is definitely related to the maturity of the fruit when picked, being liable to occur in fruit left on the trees after a certain stage. The onset in storage is longer delayed the lower the storage temperature.

It will be seen that the preventive measures to delay the onset in storage differ for the two types. A knowledge of the types of breakdown which occur in the varieties of Australian apples liable to wastage by breakdown on the overseas market is thus of great importance.

* Since such inaccurate identifications must tend to bewilder the research staffs and growers in Australia, it may be desirable that steps should be taken to secure reports which are scientifically reliable of the condition of fruit on arrival in the market.

It is suggested that the determination of the effect of temperature of storage and of maturity at picking on the development of internal breakdown should be made the first objective of a comprehensive investigation, in which would also be included the study of the other factors, orchard, &c., known to influence breakdown. In this investigation, special attention should be given to the development of breakdown after removal from storage because of the importance of this aspect in the overseas market.

The wide difference in the effect of the temperature of storage on the development of the different types of breakdown is of special significance in connexion with transport to the overseas market, since it is known that large differences in temperature and in rates of cooling occur in different parts of the hold. It may be desirable to test the effect of these differences of temperature on the condition of the fruit on arrival and during a period of several weeks after unloading, by placing experimental consignments of comparable fruit in different parts of the hold. For these experimental consignments, the varieties of apple susceptible to internal breakdown—Cox's Orange Pippin or Ribston Pippins from Tasmania and Jonathans from Western Australia—would probably be the best material to use. The experiments would be made more complete if thermographs were placed with the experimental fruit so that a definite record of the temperature was obtained.

The markedly greater wastage in large, as compared with medium, sized apples raises the question of restricting the export of the large-sized apples. Close attention will accordingly be given in England to the relation between size and wastage during the season.

3. Pears.

During the 1926 and 1927 seasons, the losses in pears have been mainly due to over-ripeness. These losses were very heavy in 1926, but were less extensive in 1927.

Such losses, due to over-ripeness, seem likely to be an inevitable feature of the Australian trade for some time to come unless the export is restricted to the varieties of best keeping quality. The most suitable storage temperature—32 degrees to 34 degrees F.—can seldom be obtained during shipment, and at the higher temperatures, which normally exist in the holds, the pears tend to become over-ripe during shipment. It is stated to be the practice to place the pears in the coldest parts of the hold, and where possible to prevent the reopening of a hold containing pears at a later port of loading. Apart from these measures, little can be done to secure a lower temperature of carriage for pears; for this the general improvement of the conditions of temperature control in the present holds or the provision of smaller holds is necessary.

There is, of course, no critical evidence that the wastage due to over-ripeness could be prevented if a lower temperature of carriage were obtained. The wastage may, in part, be attributed to the fruit being loaded in too ripe a condition, or being of a short-keeping character. It may, therefore, be desirable as suggested above for internal breakdown in apples, to test the effects of the different temperature conditions obtaining in different parts of the hold on the condition of pears on arrival, by placing experimental consignments of comparable fruit in different parts of the hold.

Although the bulk of the wastage is undoubtedly due to over-ripeness, a parcel of Western Australian Bartlett pears from an early shipment in 1927 was observed to show abnormal ripening. These pears were green in colour and firm, but the core region was brown and sleepy.

It is very difficult to obtain any reliable indication of the extent of such abnormal ripening in pears, which are sound on arrival in the market. It is therefore very desirable that, if storage work in Australia should show that any of the different varieties are particularly liable to ripen abnormally during or after removal from storage, this information should be made available so that special attention could be given to the condition of these varieties on arrival in England in order to determine the extent of the abnormal ripening under commercial conditions.

4. Grapes.

Western Australia.

With the exception of the Ohanez variety, which is, in general, sound on arrival at the market, the condition of the other Western Australian varieties—Black Malaya, Wortley Hall, Red Punće Colmar, Tehai, Purple Cornichon—is very unreliable. The cause of the deterioration is principally the separation of the berries from the stalks, commonly termed "dropping."

There seems to have been no critical work on the factors determining "dropping." For South African grapes, it is generally believed that greater "dropping" occurs in more mature fruit, but nothing appears to be known of the effect of factors such as the storage temperature on the amount of "dropping." The introduction of preventive measures into present practice must thus await the results of research work on the problem in Australia.

No reliable information has been obtained here hitherto of the deterioration in grapes which are apparently in good condition on arrival. Observations of the wastage after arrival will be made this season.

New South Wales.

The single consignment of grapes from New South Wales sent during the 1927 season was of the Ohanez variety, and was in a most unsatisfactory condition. The trouble seemed to be principally due to rotting by a species of *Penicillium*, beginning at the base of the grape.

Victoria.

In 1927, a small experimental consignment of the Ohanez variety from Victoria arrived in good condition and remained practically free from wastage for 2 to 3 weeks. The experiment was designed to test the effects on the wastage due to mould rotting of cork subjected to a sterilization treatment. The results were inconclusive, since practically no rotting occurred in grapes packed in either treated or untreated cork.

5. Prevention of Wastage.

In the introduction to this report the statement was made that the objective of the Food Investigation Board market survey was the identification of the main types of wastage, and the rough assessment of their severity. With the assistance of the Dock examinations conducted by the Empire Marketing Board, this objective has been attained. The main wastage in apples has been shown to be due to either bitter-pit or internal breakdown, and the varieties most susceptible to these diseases have been determined. The types of wastage in pears and grapes have been similarly defined. It may then be usefully considered whether further survey work in England can materially assist in the main project, the prevention of wastage.

A brief consideration of the position in regard to apples will show that the major assistance to be given by the Food Investigation Board by work in England has now been given.

The reduction of the wastage due to the two diseases, bitter-pit and internal breakdown, depends entirely on critical knowledge of the factors conditioning the development of these diseases and this knowledge can be obtained only by investigational work in Australia.

Admittedly there remain some problems which can only be tackled in England; as examples may be quoted the development of internal breakdown after unloading; the observation of the condition of experimental consignments sent to test the effect of the temperature variation in different parts of the hold; and examinational work in England to identify marks showing a high or a low proportion of wastage. It should be pointed out, however, that work on the variation in the liability to disease of different marks is not likely to reveal the factors determining this variation, unless supported by carefully planned experimental work with these marks in Australia. Such work in England cannot solve any problems, it can only suggest lines of research in Australia.

The position is very similar in the case of pears and grapes, the types of wastage have been identified, and little further help can be given.

On the whole, therefore, there can be little doubt that the work of permanent value to the Australian fruit export trade, which could be carried out in England, has now been accomplished. The future depends on the success of the Australian research investigations, and the rapid adoption in cultural and export practice of modifications conforming with the results of these investigations.

Euphorbia Drummondii, "Milk Weed," a Plant Poisonous to Sheep.

By H. R. Seddon, D.V.Sc., Director of the Veterinary Research Station, Glenfield, of the New South Wales Department of Agriculture.

(A research undertaken under the Poison Plants Committee of the Council for Scientific and Industrial Research.)

1. Introduction.
2. Suspected Cases of Poisoning of Stock.
3. Tests at Veterinary Research Station, Glenfield.
4. Conclusions.

1. Introduction.

Euphorbia Drummondii is a very common weed throughout the western, southern, and north-western areas of New South Wales, and commonly goes by the names "milk weed," "caustic creeper," "poison weed," &c. It is by no means confined to the areas mentioned,* and is plentiful along the Southern Railway Line, in the County of Cumberland, the seed having evidently fallen from passing stock trains. It is probably to be found, therefore, in all parts of the State to which sheep are travelled from western areas. It does not, however, thrive in the coastal districts, and it is apparently only on the southern, western, and north-western plains that its growth is at all prolific. During the past autumn, it has been especially abundant, and on one property visited by the writer it must have constituted 50 per cent. of the herbage. On that property it was causing no ill effects, and the fact that it may commonly be eaten with impunity will be referred to later.

It is a plant which is well known to many stock-owners, and probably no other plant has been so commonly suspected of being poisonous. No doubt in many cases there have been strong circumstantial reasons for suspecting it, but in many cases there have been good grounds for believing that the mortalities complained of have not been due to it. Another feature which would tend to bring it under suspicion is that it belongs to a group of plants which have an acrid milky latex or juice.

The plant is one which is readily recognized by its creeping habit, the stems, anything up to 20 or 30 in number, spreading over the surface of the ground from a short central stem. Along these branches are the leaves, which are small and oval, and distributed more or less evenly along the stems. The seeds are enclosed in a small three-chambered fruit. The stems may be green, or of a purplish colour, and the leaves may be tinted purple at the edges.

Like many other plants, milk weed was "reputed to be poisonous" many years ago, and, though the question as to the harmfulness or otherwise of many of these plants has not been determined, so importantly has milk weed figured that it was natural it should be one of the first plants submitted to feeding tests. In 1886, therefore, the late Mr. Edward Stanley, Government Veterinarian, undertook feeding experiments on Yanko Station. Though, initially, some difficulty was experienced in getting the sheep to take the plant, and hand-feeding had to be undertaken, it was later found that the sheep would eat up to 1 lb. of the plant, especially if mixed with a little chaff. Stanley records that over 56 lb. of the weed were consumed by six sheep in six days

* Its distribution is fairly general throughout all Australian States.—Ed.

without the animals showing the slightest ill effects. Decoctions of the plant were administered, with a like result. In view of these experiments, Stanley concluded that, though there was no doubt that losses of sheep did occur from eating the plant, such losses were not due to the plant being actually a poisonous one. Deaths were, in his opinion, due to hoven or bloat, as a result of hungry sheep gorging themselves with the young succulent plants.

Thus, for many years, it has been assumed that *Euphorbia Drummondii* (milk weed) is not a poisonous plant. (A circumstance which has assisted the continuation of this assumption has been the fact that, in several outbreaks attributed by owners to milk weed, the suspected plant has been found, on identification, not to be milk weed (*Euphorbia Drummondii*) but to be a plant which resembles it to some extent).

Owing to the suspicion attached to this plant persisting so widely, we have regarded the plant as still in the "suspected" class, notwithstanding Stanley's work.

The opinion of botanists in Australia as given in their books, agricultural journals, &c., has been somewhat at variance. Thus Bailey (Queensland) states that the plant is very poisonous to sheep; Ewart (Victoria) that it is not poisonous; Osborn (South Australia) regards it with grave suspicions; Maiden, accepting the conclusiveness of Stanley's experiments, states that it is not poisonous, though often suspected, and recalls the fact that every year, particularly about March, he gets many reports of its devastations, chiefly from the west; Herbert (Western Australia) states that it is undoubtedly poisonous, experiments on rats, both with fresh and air-dried plants, having shown this.

Some three or four years ago we tested it on a limited scale, and found that for guinea-pigs it led, at times, to death of the animals, but at other times it did not. This seemed to indicate that the toxicity was variable. What the toxic principle might be, and what were the circumstances that might cause the plant to be toxic only at certain times, we did not determine. We do not regard tests on small laboratory animals as either satisfactory or definitive, and set the plant down for testing on sheep at the earliest opportunity (the sheep being said to be poisoned under natural circumstances).

Cleland had noted that the plant contained emulsin, but his tests for a cyanogenetic glucoside were negative. In the experiments recorded by Herbert, the rats given the fresh plant died in about 24 hours after eating the plant. With the dried plant, death took place in a like time after eating the first dose, though actually the animal had another feed only 2½ hours before death. Herbert recalls that plants like sorghum, though cyanogenetic, lose their toxicity on wilting, but evidently does not suspect *Euphorbia Drummondii* of being cyanogenetic, and the symptoms described by him are not those of hydrocyanic acid poisoning, nor is the symptom of swelling of the head and neck, recorded by him as occurring in rats, seen in sheep poisoned under natural circumstances.

Summed up, therefore, we may say that the position at the time we undertook our sheep experiments was that—

(*a*) the plant was strongly suspected by some;

(*b*) feeding tests by Stanley on sheep had been entirely negative;

(c) tests for hydrocyanic acid had been negative;

(d) feeding tests on rats had shown it to be toxic for them, but that it induced symptoms not recorded as occurring in sheep, and with death more delayed in occurrence;

(e) feeding tests on guinea-pigs had shown it to be toxic at times, death then occurring comparatively suddenly, and the dead animals showing no gross lesions.

2. Suspected Cases of Poisoning of Stock.

The following, which are taken from our records, are typical of the type of mortality which is said to be due to this plant:—

A. *Wilcannia.* February, 1925.—A flock of ewes, ranging from 4-tooth to full-mouth, had been brought into the yards for crutching. They were kept in for a day and a night, and then turned into the paddock. That afternoon, 150 were found dead within a small radius. In this case, the weed was well away from water-courses, being situated on a slight rise, and the nearest tank was fully a mile away. The weed suspected was identified as *Euphorbia Drummondii.*

B. *Dunedoo.* April, 1927.—Several sheep were lost and a weed suspected. The plant submitted was identified as *E. Drummondii.*

C. *Manilla.* February, 1928.—A cultivation paddock of 80 acres, with 30 acres of black soil at one end. The plant suspected grows only on black soil; 300 sheep were placed in this cultivation, and five days later nine were found dead. They died without a struggle. Previously 30 head of cattle and 14 horses had been in the paddock for a month and none had suffered any ill effects. The plant forwarded was identified as *E. Drummondii.*

D. *Coolah.* January, 1928.—Dead sheep were found on a patch of the plant (milk weed). They became affected within 24 hours of placing in the paddock. No symptoms were seen. Supplies of suspected plant were forwarded.

E. *Coolah.* February, 1928.—Two cows died suddenly, and this plant was suspected.

F. *Ariah Park.* March, 1928.—This outbreak was investigated by Mr. A. L. Rose, District Veterinary Officer, and Mr. Stock Inspector Whyte, of Wagga, and the following is taken from their reports:— The sheep in question were a lot of 1,100 mixed sheep in good condition. They were placed in a fallow paddock almost bare of feed, where they remained for four days, it being the owner's intention to crutch them before putting them into another paddock where there was plenty of young green feed. Grasshoppers then visited the place and ate out this second fallow, leaving *E. Drummondii* and little else. The sheep were placed in this second paddock on the afternoon of 13th March, when they moved down to a depression where the plants were most plentiful. The area of this paddock, it may be noted, was only 150 acres. The owner arrived the following day to take his sheep away to be crutched, and, instead of finding them spread over the paddock, he found them grouped together in the hollow. Many were dead, and many others were down and unable to rise. This was 23 hours after the sheep had been put in, and it was evident that a number had been dead for some hours. Owing to the large number of sheep that were sick, the owner was unable to move them, and it was not until two or three days later

that the remaining sheep were moved. Even then, 100 were too sick to travel, and were left in the paddock. The total losses were about 200, and practically all of these died early. The sheep that did not die early, even though very sick, recovered. Driving the sheep had the effect of bringing on symptoms in apparently healthy sheep, but after a little rest they recovered and travelled normally with the others.

The symptoms described were as follows:—

"Staggering gait, affected sheep get down and are unable to rise; they have shivering fits and froth at the mouth, while the head is usually extended or bent stiffly back. No diarrhœa." On post-mortem examination some congestion of the fourth stomach was noted. That the sheep had, in fact, eaten a large amount of the plant was shown by the identification of the rumen contents by the Government Botanist.

This last-mentioned mortality presents a feature not generally associated with this type of case, namely, that though the majority of the deaths occurred during the first 24 hours after sheep had access to the plant in quantity, in a number, symptoms persisted even for days, and, in some cases, in sheep which appeared to be healthy symptoms became evident on driving.

G. *Various Districts.*—Reports of losses in sheep which had been yarded for some time, or of de-trucked sheep allowed free access to the plant. Note:—The outstanding feature in those cases where we have information is that the sheep involved are hungry. Sheep commonly graze in paddocks where the plant is plentiful without apparent ill effects, unless other feed is scarce.

3. Tests at Veterinary Research Station, Glenfield.

Owing to what we regarded as an unsatisfactory position with regard to this plant, arrangements were made—(*a*) to collect information from the various inspectors of stock as to their experience of the plant; and (*b*) to have supplies forwarded for feeding tests. The identification of plants has been undertaken by the Director, Botanic Gardens, Sydney.

The general experience of inspectors was that, though ordinarily this plant might cause no harm, although it occurred in the pasture, yet if hungry sheep had sudden access to it, the result might be the rapid death of a number of the animals. Our suspicion that the plant was indeed a toxic one was therefore strengthened, and in view of Stanley's work it became more imperative than ever that it should be investigated more closely. In January last, therefore, supplies from two separate districts were tested.

It was found that, though sheep would voluntarily eat a little of the gathered plant, especially if it were chopped up and mixed with a little chaff, they could not be induced to eat it really readily and in what we deemed adequate quantities for satisfactory determination. For example, two sheep were penned and during six days consumed between them a total of 22½ lb. of the plant without showing ill effects. Recourse was then had to a method which we have used largely in our plant tests. A quantity (1 lb. to 2 lb.) of the plant was passed through a mincing machine and macerated in water overnight. Next morning the mass was expressed and the fluid (2 to 5 pints) administered to a sheep as a drench.

By this means, one particular supply of the plant was found to be highly toxic. This was secured in the Brewarrina district by Mr. Stock Inspector Ovens. Sheep drenched with such a "watery extract" from as little as 1 lb. of the air-dried plant were found to become severely ill within a few hours of administration of the drench, and to show symptoms suggestive of prussic acid poisoning. Death occurred in from 2½ to 20 hours of drenching, and post-mortem examination showed comparatively slight lesions—such as one usually finds in cases of prussic acid poisoning. A pronounced odour of prussic acid was detectable whilst examining the contents of the alimentary canal.

To confirm our suspicion, specimens of the plant used, and of stomach contents of sheep that died following administration of these "extracts" were submitted to Mr. H. Finnemore, of the Pharmacy Department of Sydney University, who had them examined by Mr. C. B. Cox (C.S.I.R. Research Officer), when it was found that they all gave positive reactions for prussic (hydrocyanic) acid.

Whilst these tests were being undertaken, the mortality E referred to above was reported and supplies of the weed were obtained from that district. A test showed that the plant there was likewise toxic, though death in this case was not so rapid.

Other supplies have been tested in a similar manner, however, and have been found to be devoid of toxic effects.

That the toxic effects seen by us are due to the presence of hydrocyanic acid we feel no doubt, for Mr. Finnemore informs us that quantitative determinations of the dried plant from Brewarrina have shown that it may contain 0.085 per cent. HCN, or 385 mgs. HCN, per 1 lb. weight of dried plant. Tests of supplies found to be non-toxic by us have given a negative reaction for HCN when tested chemically.

4. Conclusions.

1. There is strong evidence that under certain circumstances sheep may die from the effects of *Euphorbia Drummondii.*

2. The history in these cases shows that such is seen especially in starving, or at least hungry, sheep which suddenly have access to large quantities of the plant.

3. Though under such circumstances some of the losses may be due to hoven, there is evidence that the losses at other times are not due to such.

4. *Euphorbia Drummondii* may, at times, give off hydrocyanic acid in such quantities that even as little as 2 lb. or 3 lb. of the plant may contain a lethal dose.

5. There is every reason to believe that sheep may, under natural circumstances, be poisoned by hydrocyanic acid from the plant. The history, &c., of cases strongly supports this view, though up to the present we have not been able to secure material from a recently dead sheep for the requisite chemical examination.

6. *Euphorbia Drummondii* does not always give off hydrocyanic acid, and the conditions which determine the production of the cyanogenetic glucoside in this plant are not yet known.

7. *Euphorbia Drummondii* (milk weed) must be added to the list of dangerous cyanogenetic plants and trees which includes blue couch

(*Cynodon incompletus*), bird's foot trefoil (*Lotus australis*), rosewood (*Heterodendron oleaefolium*), and, probably, variegated thistle (*Silybum mariana*).

Further work to determine the causes of variation in cyanogenesis is now being undertaken.

For assistance in some of the experiments the writer is indebted to Mr. Grahame Edgar, B.V.Sc., McGarvie Smith Research Scholar.

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A Plant Pathology Glass-house at Adelaide.

Erected by the Council for Scientific and Industrial Research on the grounds of the Waite Agricultural Research Institute, University of Adelaide.

By G. Samuel, M.Sc., Plant Pathologist at the Institute.

The investigation of "spotted wilt" of tomatoes was one of the first problems in plant pathology which the Council for Scientific and Industrial Research undertook. All the evidence available pointed to this disease being a "virus" disease, and to the probability of its being transmitted from plant to plant by some insect vector. For an investigation of the disease, therefore, it was necessary to construct a glass-house which would allow control of all insects in the experimental work. The following short description, together with the accompanying photographs, will give some idea of the construction of this house, which was completed in May, 1927.

The dimensions of the glass-house are 48 feet by 17 ft. 6 in., and there is a wire enclosure 32 feet by 17 ft. 6 in. at the northern end for protecting out-door pot experiments from birds (Fig. 1). The glass-house itself is divided into one large compartment at the northern end, and eight small compartments at the southern end, all opening into a central corridor (Fig. 2).

The floors, the walls to a height of 2 ft. 6 in., and the benches are all of reinforced concrete with smooth cement finish. The floors slope to one trapped drain-hole in each compartment, and junctions of walls with floors or benches are all rounded. The superstructure, carrying the glass, is of standard steel frames held in place by hardwood joists.

The whole side of the glass-house may be opened by means of windows hinged at the top and manipulated from the inside of the compartments. The window openings are protected by fine brass wire-gauze screens (100 mesh to the inch). These screens are fixed over the openings by thumbscrews, and are bedded against a layer of felt to ensure their being insect-proof at the sides. Being easily removable, gauze of any desired mesh can thus be fitted over the windows in these screens. The ventilators at the top are similarly protected by fine gauze screens, and may be opened or shut from the inside with a special opening rod. The doors have felt-lined dust excluders which press against the floor when shut.

Finally, each compartment is provided with a sink, two taps, and a water-tight electric power-plug. There are no cupboards or drawers except in the big compartment at the end. Hot-water radiators, controlled by stop-cocks, and worked from a boiler in a pit at the southern end of the house, are also now installed in each of the eight small compartments.

It will be evident from the above that each of the small compartments is a separate experimental unit which allows complete control of insects feeding upon the plants. All soil used for seed-pans or pots is sterilized before entering the glass-house, and seedlings can thus be raised which have been protected from insects from the time of germination. One of the small compartments has been set aside as a nursery for healthy seedlings, and these seedlings are the only ones used in the experimental work on the transmission of the virus.

Methods have now been worked out giving complete control of the experimental insects during breeding and handling for inoculation, so that there is practically never an escape. At the end of each experiment, however, the small compartments can be completely cleared, fumigated, and washed, so that another experiment can follow along immediately with seedlings raised in the insect-free nursery. The combined control given by these insect-proof compartments, and the inoculation technique as now developed are most important in work with virus diseases such as spotted wilt, where symptoms are the basis of diagnosis, and any unnatural conditions, such as confinement under screens or glass globes, are liable to alter the growth of the plant and the expression of the symptoms of disease.

A preliminary note by H. A. Pittman, giving an account of the discovery of a species of thrips as the insect vector of spotted wilt, was published in the second number of this *Journal*. The experiments were performed in the glass-house described above, and a more detailed account of further work on the disease will shortly be ready for publication.

Economic Entomology in the United States.

By F. G. Holdaway, M.Sc.

Mr. F. G. Holdaway, M.Sc., who is a holder of a research studentship under the S. and I. E. Fund, and who is at present continuing his entomological studies at several Universities in the United States, has recently furnished the Trustees with a report of a tour of entomological laboratories which he has made in the United States and in Canada. During that tour a special point was made of studying the major problems which concern exotic insects introduced into America from other countries, and also the problems associated with the main agricultural crops. As the report contains much of interest it has been considered desirable to publish it in a slightly abbreviated form.—Ed.

1. United States Bureau of Entomology, Washington.
2. Gypsy and Brown-Tail Moth Investigations.
3. European Corn-Borer.
4. Japanese Beetle.
5. Mosquito Control Work on the Salt-marshes of New Jersey.
6. Codlin Moth Problem.
7. Tobacco Insect Chemotropic Work.
8. Cotton Insect Investigations.
9. Insects affecting Domestic Animals.
10. Angora Goats.
11. Citrus Insect Biological Control Work in California.
12. Insignis or Monterey Pine.
13. Californian Quarantine.
14. Canadian Grasshopper Problem.
15. Oriental Fruit Moth.
16. Conclusion.

1. United States Bureau of Entomology, Washington.

It was very significant that most of the entomologists met with at this Bureau were of the opinion that, although a tremendous amount of work had been done in the past, comparatively little had been done that had been directed at the roots of the problems, much of it being little more than life-cycle work and control measures aimed at quick relief. The realization of the need for more fundamental work is evidenced in the appointment of several entomologists whose chief duty will be to carry out fundamental investigations along physiological lines.

2. Gypsy and Brown-Tail Moth Investigations.

The insects under investigation in this project include the gypsy moth, *Porthetria dispar,* the brown-tail moth, *Euproctis chrysorrhea,* and the satin moth, *Stilpnotia salicis*, the larvae of all of which attack the foliage of trees. All of these insects came originally from Europe, the gypsy moth in 1869, the brown-tail moth in 1897, and the satin moth in quite recent years.

Of these the gypsy moth is the most important. The brown-tail moth, which soon after its introduction into the United States constituted a serious pest, has now decreased in importance. It occurs in such small numbers as not to claim the attention that the gypsy moth does. It causes damage only in limited coastal areas of Massachusetts, New Hampshire, and Maine. Apparently it has reached a balance in its new environment, but entomologists are rather diffident of expressing an opinion as to which factor has been most important in bringing this about. The insect enemies from its native home have undoubtedly played an important part. However, it seems that apart from parasites and predators, there has been a constitutional adjustment to a new

environment in which the insect originally increased in abnormal numbers. That this is a reasonable possibility, the modus operandi of which is as yet not understood, but in which climatological factors probably play a part, is supported by what is found to be occurring with the Japanese beetle. The latter is another exotic insect, which is found to be most serious in the new areas of infestation, the "front line of attack" as it were, and which apparently, quite apart from introduced predators, is of less importance in the region of original outbreak.

The present range of the gypsy moth, the most important of the three, includes portions of the New England States, Massachusetts, Vermont, New Jersey, Maine, and the Dominion of Canada. The project for its control involves the employment of 250 men, and is a striking example of what could have been prevented had the work done by Massachusetts in wiping out these insects in the early stages of their spread, been continued a little longer. In 1900, the insects were considered to have been so nearly exterminated as to be of no importance and work on them ceased. In looking back, one can see what might have been done to wipe out the invaders. The lesson has been learnt, and other countries should profit by it.

Control measures at present consist of scouting for colonies along a barrier zone, artificial control by spraying particularly in the barrier zone, and biological control by importation and propagation of the natural enemies from Europe. Much valuable information has been obtained on the life-histories and habits of parasitic insects in connexion with this work, and very interesting are the uses made of various habits of such insects in assisting in the work of their propagation. Of 50 parasites and predators imported, 15 have been established. The Tachinid, *Compsilura cincinnata,* has spread beyond the range of the gypsy moth.

3. European Corn-borer.

The European corn-borer, *Pyrausta nubilalis,* was discovered in the United States in 1917. At present, one infested area occurs on the east coast of the States, in the New England region, and another in the Lake Erie region of both the United States and Canada, i.e., in the States of New York, Ohio, and Michigan, and the Province of Ontario respectively.

I have visited both the parasite laboratory at Arlington Heights, Massachusetts, where parasites from Europe are reared and propagated for distribution to infested areas, and also the Sandusky field laboratory in Ohio, where detailed life-histories and experiments on cultural measures for control are being carried out each season, and where parasite liberation and recovery work to determine establishment takes place.

The insect lends itself to cultural control measures. Hibernation takes place as a larva in the cornstalks about 6 inches from the surface of the ground. The result is that farm implements are being developed capable of cutting corn for ensilage close to the surface of the ground, so that the larvae may be collected in the stalks and thus destroyed. When corn is grown for grain, field clean-up measures before the spring constitute an important control. However, the main practices in the corn belt are to plant corn continuously on the same land without any other rotation, and after the crop is harvested to

"hog it down" with pigs. Both practices will have to be altered if the insect is to be controlled at all when it spreads into the main corn belt. From inquiries made, it appears that the use of rotation systems is not favoured by the farming community. Much education and probably the loss of many crops will occur before the benefit of such measures will be realized.

During last spring, the Federal Government appropriated £2,000,000 for corn-borer control. The scheme adopted was as follows:—To those growers who carried out a satisfactory field clean-up the Government paid 2 dollars per acre. In the case of those growers who did not do a satisfactory clean-up, Federal men went in and did the job, and such farmers did not receive the 2 dollars per acre.

A remarkable fact has been demonstrated in the life-history of the corn-borer in the two different areas of infestation. In New England there are two generations per year, while in the Northern States, Canada, and France, only one generation occurs. This is not merely due to difference in climatic conditions, for insects from the one-generation areas transferred to the two-generation area have, for a continuous period of five years, retained the single generation alongside insects which complete two generations.

4. Japanese Beetle.

I spent two days at the Japanese Beetle Laboratory and was able to see a fairly heavy infestation of the adults in a nearby orchard, the beetles being particularly numerous on prune trees. I was able to meet the various men in charge of the different phases of the problem, and to obtain an insight into their respective sections of the work.

The Japanese beetle, *Popillia japonica,* is a native of Japan, and was first found in a nursery in New Jersey in 1916. In seven years, it had spread over an area of 2,240 square miles in New Jersey and Pennsylvania It is believed that it came to the United States as a larva in the soil around the roots of certain nursery plants. The larva belongs to the "white grub" group, and the insect is important, because of injury caused to plants by both larval and adult stages. On account of the large number of economic plants on which the adults will feed, the damage done by this stage is more evident and more easily estimated than that done by the underground larvae. The damage to plants from attack on the roots has been most pronounced in pastures and lawns, but some economic plants have suffered. Of the economic plants attacked by the beetles, the most important are apple, peach, sweet-cherry, plum, grape, blackberry, clover, soy-bean, and corn.

The phenomenal increase of the insect since it became established is well shown by records obtained in 1923, seven years after its discovery. When first found in 1916, only a dozen adults could be found. Seven years later a collection, made in the morning, when the beetles were inactive, yielded 208 gallons of beetles from 56 trees in a little over two hours. The following morning the trees were nearly as heavily infested again. It can be seen that the insect has not merely established itself in America, but that it is thriving there.

At present, control measures consist of spraying and of trying, by the introduction of natural enemies, to establish a natural balance such as occurs in Japan, where the insect is of practically no economic

importance. Nine parasites have been introduced from Japan and chosen, but not all have been established yet. They consist of 3 species of Tachinids, 2 Dexiids, 4 Scoliids, and one predator—a Carabid.

5. Mosquito Control Work on the Salt-marshes of New Jersey.

I was fortunate in being afforded facilities for seeing a good deal of the New Jersey mosquito problem from the ditching of new marsh land to the reclaimed land which now supports industrial plants, railway yards, an aeroplane factory, and a flying field. Previously water covered the area, and it was impossible for people to live in the vicinity on account of the mosquitoes.

At present there are two principles in use in the New Jersey mosquito control work. In the first, use is made of "tide gates," which, after trenching has been done, work automatically to drain the marsh, while in the second the trenching allows the free movement of tide water. This latter movement facilitates the migration inland of larva-eating minnows which frequent the estuaries of streams, and which require some movement of water for life.

In the area where "tide gates" are in use, series of trenches have been dug to drain into natural waterways such as drains and creeks. The "tide gates" are built at the outlets of these waterways to larger tidal waterways. They consist of barricades with a central gateway over which hangs a gate hinged at the top. The lower level of the gateway is made 1 foot above the mean level of the tide outside, so that when the tide drops the water inside flows out by pushing open the flap-gate. As the tide rises to the level of the inside water, the gate closes, and on further rise the pressure of the tide which is now higher than the level of the water inside, keeps the gate closed and prevents the water running in.

This work was commenced in 1901, and all that is required now is inspection of waterways and tide gates to locate obstructions.

In Southern New Jersey I saw preliminary operations with a new ditching machine designed so that the pressure on the marsh is only 1 pound per square inch. The caterpillar treads are 46 inches wide. Here 10,000 acres of marsh land are being trenched. The high tides which occur about once a week leave breeding pools for the mosquitoes. The principle is to provide ditches to drain off the water left by the high tides, and also to provide waterways for the incoming tide which thus carries minnows inland. These then destroy any larvae which may have started to breed in quiet recesses. The most satisfactory ditch in this case is found to be one 20 inches deep and 10 inches wide.

6. Codlin Moth Problem.

In view of the importance of this insect in the fruit industry of Australia, wherever I have had an opportunity I have sought information on it.

The recent embargo imposed by Great Britain on apples carrying more than 1-100 grain of arsenic per pound has caused a stir in fruit circles in the United States, but it has also been responsible for a stock-taking in the methods of codlin moth control.

From what I could gather during my recent tour, it appears that, generally speaking, orchardists have relied solely on spraying for control. The life-history of the insect indicates that the hibernating larva is the most logical stage to attack, and that the more intensive the measures directed against this stage, the greater the chances of obtaining a high percentage of clean fruit the following year. The next most vulnerable point of attack is the first brood. This is important, not so much on account of the damage which this brood does, but because it is responsible for the increase in population of later broods which, occurring after the fruit is well developed, are capable of serious damage. The importance of packing-house and orchard sanitation against the larvae cannot be over emphasized. Recent tendencies have been towards their being overlooked, but a revival in attention to such matters is evident. As regards the first brood, a large proportion of eggs are laid on the leaves, and the larvae during their early life will feed on the under surface of the foliage. Thus the first sprayings should be thorough and the "under spray" work emphasized.

Many orchardists in the Western States have installed washing machines in which the fruit is treated with dilute hydrochloric acid and washed to remove the arsenical residue. This may meet the situation for the time being, but is not leading to any further knowledge on the insect.

7. Tobacco Insect Chemotropic Work.

There is evidence throughout the States of increasing interest in insect behaviour—a most important line of investigation—as a possible avenue for control measures.

The most important tobacco insects in Tennessee are the larvae of two species of Sphingid moths which, on account of their large size, are capable of very serious damage to the leaf.

It has been found that amyl salicylate, a substance having a similar odour to that emitted from a flower at which the moths normally feed, is very attractive to the adults. The work is very promising. At present the attractant is being used in conjunction with large traps for record purposes, but there is promise of the development of a poisoned bait either in the vicinity of the attractant or incorporated with it.

An interesting and important development in this work is the detection of a marked colour response which has necessitated the colouring of the vessels containing the attractive principle so as to resemble the flowers.

8. Cotton Insect Investigations.

One of the main reasons for my visit to the Cotton Insect Laboratory in Louisiana was to discuss with entomologists there the work which has been done recently on boll-weevil attraction. To my knowledge, this is one of the first pieces of work in which a successful attempt has been made to isolate from a host plant the attractive principle, which induces an insect to visit a plant and oviposit there. The work was carried out on a large scale by the United States Bureau of Chemistry in conjunction with the cotton entomologists. The result has been the isolation of trimethylamine and ammonia from the cotton plant extract. The boll-weevil reacts chemopositively to trimethylamine, and it has been concluded that this substance is the main attractive principle.

More recently the dew from the cotton plant has been analysed and ammonium hydroxide has been found in higher concentration than trimethylamine. It can readily be seen that the work is far from complete, but such work is of fundamental importance, not only from the stand-point of the cotton insects, but also by reason of the principles it demonstrates which may be applied in the case of other insect pests.

9. Insects Affecting Domestic Animals.

In Texas, I was fortunate in meeting the entomologists engaged in work on insects affecting domestic animals, and in seeing some of the experimental work being carried on, notably in control of the dread "screw worm," *Cochliomyia macellaria,* which breeds in carcasses, but also in living animals, particularly cattle, sheep, and goats, especially after injury, accidental or surgical, or at the time of parturition.

After my visit to Texas, I am fully convinced that if, as I believe is the case, Australia is still free from such live-stock insects as "screw worm," and also "ox warbles," *Hypoderma lineata* and *Hypoderma bovis,* every precaution should be taken to prevent their becoming established at home. Blow flies or "wool maggots" as they are called here, are present in addition to "screw worm."

"Screw worm" work consists in two lines of investigation—

(*a*) Repellants (negative chemotropism), also with larvacides incorporated.

(*b*) Attractants (positive chemotropism).

The most promising repellants for protecting wounds are certain pine-tar extracts at present known only by number. Experiments aimed at finding a satisfactory combination of repellant and larvacide, such as benzol, are in progress. Such a combination is hoped to meet the desire of stock-owners for a "one bottle" treatment for use on fresh wounds, as well as those which have become blown.

The work on attractants is of fundamental importance. It consists in an attempt to determine the attractive principle in the most important breeding places at which females oviposit. Progress of such work is slow, owing to the expense and difficulties involved in the chemical work necessary.

Work on "horn fly," *Dermatobia* (*Lyperosia*) *irritans* consists in finding a suitable contact insecticide which it is hoped eventually to incorporate with a repellant to protect the cattle from further attack.

10. Angora Goats.

While on the question of live-stock it may be of interest to note that, in recent years, there has been a remarkable stimulus to the Angora-goat industry in Texas. The annual production of mohair in the United States is now 10,000,000 lb., of which a large proportion is produced in Texas. Goats are forming an accessory to both cattle and sheep raising, and a good deal of Texas country which is unsuitable for cattle or sheep carries shrubby vegetation which is suitable for goats. The result is that an important industry has been developed in country previously considered of practically no value.

11. Citrus Insect Biological Control Work in California.

The control of insect pests by biological means is now practised on a large scale in California, particularly in the control of citrus mealy bugs.

These bugs, *Pseudococcus citri* and *P. citrophilus,* are difficult to control by either spraying or fumigation. The Australian ladybird *Cryptolaemus montrousieri* attacks both mealy bugs readily. Moreover, it has been found to be a suitable insect for artificial propagation and liberation in infested orchards. The procedure is as follows:—Potatoes, which are alternative hosts of the citrus mealy bugs, are sprouted in trays of sandy soil in dark rooms. The yellowish-green sprouts are very suitable food for the mealy bugs. They are artificially infested, and, when infestation has reached a certain stage, *Cryptolaemus* adults are liberated in the rooms. When the progeny of the *Cryptolaemus* are adult, they fly to diffusely lighted windows and are collected there for shipment to citrus-growers at a cost of one cent (one half-penny) each.

In winter, the rooms are artificially heated and thus propagation is made possible throughout the year, and particularly during the winter, so that large stocks of ladybirds are available in the spring.

Of the insectaries for breeding *Cryptolaemus* which I visited, one was run by the county, and ladybirds were being sold for one cent each; a second was run by the growers, but subsidized by the county; and the third was purely a growers' co-operative concern, each grower contributing 1.5 dollars per acre for insectary maintenance, and receiving ladybirds free in numbers comparable to the degree of infestation of his orchard.

The rate of distribution varies, but averages 10 to 15 per tree. In some cases 10 ladybirds are placed in every tree in the orchard, while in other cases 25 may be placed in each tree in the infested area only.

The co-operative insectary visited puts out an average of 1,400,000 ladybirds per year, all the labour being done by one man. In a large county insectary, 20,000,000 to 30,000,000 are put out in a season. No reliance is placed on the *Cryptolaemus* over-wintering in the orchards, but beetles are bred artificially, and thus kept on hand for the first sign of infestation in the spring.

The fact that mealy bugs are difficult to control by the recognized spray and fumigation methods, and also the fact that *Cryptolaemus* lends itself in many ways to artificial breeding and liberation has made the project a great success. The principle may be adopted in other cases, but it is very evident that not all predators and parasites would lend themselves to this system, and to undertake such methods without a full knowledge of the habits of both host and predator would be folly.

Of great importance are investigations now being begun to ascertain if it is possible to adapt the main general principles of the *Cryptolaemus* work to a native insect, a Chalcid egg-parasite. The results of such work will be eagerly awaited.

It is of interest to note in passing that Mr. Harold Compere, of the Citrus Experiment Station, has recently left for Australia to make a thorough study of predators and parasites of citrus insects with the idea of importing them to California.

12. Insignis or Monterey Pine.

Pinus insignis, known in the United States as *Pinus radiata,* or the Monterey Pine, from its native home at Monterey, on the Pacific Coast, is being grown extensively in certain parts of Australia, and in particular in South Australia. At the instigation of the Conservator of Forests of South Australia I last year made observations on a malady affecting this species. I found that a condition often associated with the malady in question also occurred separately, and that there were at least two different maladies calling for attention. (There is also still another but quite distinct.)

In view of the importance of the insignis pine to Australia as a soft wood, I took the opportunity of observing it in its natural habitat, and of obtaining information as to its insect fauna. It is remarkable that, in Australia, this pine makes much better growth than in its native home, and I think there is little doubt that one reason is that it has fewer insect enemies in Australia than in California, where it has a large number. However, of those it has, it is not unlikely that some may be identical with those in its native home, and work on its insect fauna is needed.

It is important to notice that the pine Aphid, occurring on the insignis in California, *Pineus pinicorticus,* is heavily parasitized by a Hymenopteron, recently named by Mr. Harold Compere. This point should be borne in mind when the pine *Chermes* on *P. insignis* in Australia is studied, for the Californian parasite might prove a suitable insect to import.

13. Californian Quarantine.

While in San Francisco, I took the opportunity of calling on the local quarantine officers. I found that the insect regarding whose entry into California there is most anxiety is the Mediterranean fruit fly, which occurs in Australia and in the Hawaiian Islands.

14. Canadian Grasshopper Problem.

It has been interesting to discuss the grasshopper problem with the entomologists of both the mountainous province of British Columbia and the prairie province of Manitoba. The problem is different in the two places. In British Columbia, the main damage is to the grazing lands, which are at times completely eaten out. After a number of years, the entomologists came to the conclusion that the grasshopper problem on the grazing ranges was accentuated by, if not entirely due to, an accumulation of grazing effects.

No permanent or material damage was done to the range grasses prior to 20 or 30 years ago, i.e., when range grazing was still light and not continuous. Over-grazing, which has prevented the seeding of many of the dominant grasses, which are of important fodder value, has gradually changed the flora of the regions so used, thus lessening their grazing value and improving the conditions for hopper increase. It has been found that the most injurious species of grasshoppers are those which prefer an "open, bare, parched, low-grassed range condition." This is the condition which has been brought about by over-grazing.

In order to obtain evidence that would confirm the general observations with regard to over-grazing, for many cattle-owners still maintain that the lack of fodder was directly due to hoppers, the entomologists selected a 5-acre plot, in a heavily over-grazed section, and fenced it in the spring of 1921. Very striking evidence was obtained that grass depletion on the ranges was due to over-grazing. A few points brought out were as follows:—

(*a*) The grass on the over-grazed range could not seed.

(*b*) The continual crop of young blades endeavouring to perform their function were kept eaten down by cattle and those that escaped were destroyed by hoppers.

(*c*) The protected pasture was untouched until no grass remained on the range. Seed by this time had matured.

(*d*) What damage was later done to the protected area by hoppers was slight and not permanent, for the seeds were mature.

(*e*) The over-grazed condition made a very extensive egg-bed which militated against the effectiveness of parasites and predators.

It is not my purpose to go into the details of bait control during plagues, but I feel that it is important to draw attention to this very important relation between grazing and pest outbreak. One often hears the statement that pest production is due to an upsetting of environmental conditions. That this is so is probably true of most important insect pests, but it is seldom that such remarkable evidence on the effect of changed environment on insect prevalence can be obtained as the one just mentioned. The conclusion regarding this work is summed up in the following statement:—"The judicious management of cattle within selected grazing limits is the keynote of success in grasshopper control on the ranges."

On the prairies, where by extensive crop planting the normal environment has been altered and will remain artificial to some extent, a close study of the hoppers under varying climatic conditions in order to assist in the artificial measures which must be used, is necessary. Important in this connexion is the knowledge that sunlight materially affects egg-production, and thus the building up of plague conditions. The amount of sunlight during a season thus serves as an indication of grasshopper infestation in the succeeding year. A knowledge of the optimum feeding temperature has also been shown to double the efficiency of poison bait distribution.

15. Oriental Fruit Moth.

The Oriental fruit moth, *Laspeyresia molesta* Busck, is attracting considerable attention in some of the fruit-growing districts of the East United States, particularly in connexion with peaches. The first generation attacks the terminal buds and bores down the stems. By the time the second generation of moths is active the fruit is set, and the larvae do considerable damage to the fruit, which externally may show little or no sign of the damage inside.

Up to the present the problem of the control of this insect has baffled those workers engaged on it.

A point to which I wish particularly to draw attention is the possible original home of this insect. There is little doubt that the insect reached America from Japan in Japanese flowering plum trees. However, there is a feeling in some quarters of America and Japan that Australia is the original home. The insect apparently occurred in Australia before it had attracted attention in America, and from a comparison of larval material it appears that it is the same insect as has been referred to by W. W. Froggatt.

Should *Laspeyresia molesta* attract considerable attention in Australia in the future, it is important that the above-mentioned points should be borne in mind. If the insect does not become serious, it is also important, for it might be that useful parasites are present, and such information would be of great importance to countries not so fortunate.

16. Conclusions.

It may be of interest to summarize briefly some of the main observations of the trip.

Although attempts to understand how it comes about that an insect is a pest are not very numerous, the general trend of investigations is improving very markedly, and will tend to re-establish a balance in nature, the upsetting of which by the artificialities of civilization in its varied phases, has been largely responsible for the fact that insects are pests. The re-establishment of a balance is an ideal which, by the very facts of civilization, will probably never be attained, but it is an ideal towards which all energies should be directed.

To attempt to bring about a balance by studying natural checks such as insect parasites and predators with an idea to their transference from one country to another is all important. A great deal of progress has been made in recent years, but such work is slow and beset with many difficulties, and, moreover, it is not suitable in the case of every pest.

The gypsy moth present now in the United States for nearly 60 years has been attacked from the stand-point of biological control for 20 years, and still an army of workers must carry on with the work. However, in such work lies hope of control of a lasting nature.

The importance of rotation or crop diversification, which is an important measure in the control of many pests, is not always fully realized by agriculturalists. Its adoption must come in the control of the cotton boll-weevil, the European corn-borer, and such cereal insects as the wheat stem saw-fly.

The inter-relation of the pastoral and the agricultural industries is gradually being better realized. The relation of grasshopper plagues has been established in Canada. On the Santa Rita Range reserve in Arizona, the United States Forest Service and the United States Biologial Survey are co-operating in floral regeneration observations from a grazing stand-point, and with special reference to herbivorous mammals. From an entomological stand-point it is unfortunate that an ecological study of the insects in such observational areas is not also being made.

The Tannin Extract Plant at Crawley, Western Australia.

By Professor N. T. M. Wilsmore.

The erection of the tannin extract plant described below was completed towards the end of the first half of the year 1928, and the plant has now been put into operation. On the occasion of its opening, Professor Wilsmore prepared a brief account of the apparatus and machinery that it contained, and also of the work it was intended to undertake. That account is printed below. Further details of the co-operative agreement reached between the Council, the Forests Department of Western Australia, and the University of Western Australia, are given in the First Annual Report of the Council. —Ed.

1. Introduction.
2. Raw Materials to be studied.
3. Process.
4. Buildings and Plant.
5. Staff.

1. Introduction.

The object of the plant is to investigate on a semi-technical scale the possibility of the commercial manufacture in Australia of tannin extracts from Australian raw materials.

The more important items of the plant were bought some years ago by the former Institute of Science and Industry on the advice of Mr. D. Coghill, the Institute's officer in charge of tannin investigations, but as funds at that time were insufficient to complete and erect the plant, the items that had been bought had to be stored in Melbourne. In 1926, shortly after the Institute had been reconstituted and become the present Council for Scientific and Industrial Research (hereinafter referred to as "C.S.I.R."), Mr. S. L. Kessell, Conservator of Forests, suggested that, as Western Australia is rich in potential raw materials for making tannin extract, the Forests Department might co-operate with C.S.I.R. in defraying the cost of completing, erecting, and running the plant, provided it were erected in Western Australia. This suggestion was approved by the State Government and by C.S.I.R., and a Committee, consisting of Mr. S. L. Kessell (Chairman), and Professors Whitfield and Wilsmore, was appointed by C.S.I.R. to take charge of the work.

With the consent of the Senate of the University of Western Australia, a site for the plant was selected on University land, adjacent to the boiler-house attached to the School of Engineering and Mining at Crawley, and it was agreed that steam for working the plant should be obtained from one of the University's boilers on condition that C.S.I.R. undertook to defray the cost of fuel, attendance, and incidental repairs to the boiler. Work was begun in May, 1927. The design and construction of the main building and of the adjacent chemical laboratory were in charge of Mr. A. R. L. Wright, L.R.I.B.A., and most of the plant was installed under the direction of Mr. Stanley A. Clarke, B.E., A.M.I.E.A., engineer to the Forests Department.

2. Raw Materials to be Studied.

Amongst the most abundant potential sources of tannin in Western Australia are karri bark (*Eucalyptus diversicolor*), marri kino from the marri or redgum tree (*Eucalyptus calophylla*), the bark of ridge gum (*Eucalyptus alba*), and various wattles and mangroves. Of these

materials, karri bark is the most readily obtainable—at present thousands of tons of it are burned annually at the saw-mills in the karri country. Marri kino has the highest tannin content, but it has to be specially collected, and it requires chemical treatment to get the tannin permanently into solution.

Raw materials from the other Australian States will also be studied in the plant, one that seems promising being wattle tops from South Australia.

3. Process.

This will vary in details according to the material being treated. In general, the raw material is first pulverized, and then leached with water—hot or cold, as needed—in a series of vats or "leaches." The weak liquor so obtained is concentrated in a two-stage evaporator and converted into concentrated liquid extract, which, in turn, can be evaporated further in a "Kestner" dryer to give solid extract. As solutions of tannin turn black if they are allowed to act on iron, all metal parts of the plant with which these solutions may come into contact must be made of brass, bronze, or copper.

4. Buildings and Plant.

Buildings.

The main building, in which most of the plant is housed, is of corrugated iron on jarrah framing, and is 50 feet long by 25 feet wide, with walls 17 feet high, and a gable roof. Adjoining the main building are a shed 25 feet by 25 feet for storing bark and other raw materials, and a building 35 feet by 15 feet containing a chemical laboratory and office. The old Tiemann kiln, formerly used for experiments on the seasoning of timber, will also be used for storage.

Water, Steam, and Electric Supply.

Water for cooling purposes and for leaching is obtained by means of an electrically-driven centrifugal pump, capable of delivering up to 4,000 gallons per hour, from a well 4 feet by 4 feet by 32 feet deep, situated in one corner of the bark shed. Water from the town mains is also laid on for use in the laboratory and plant, and to supply a fire hydrant.

Steam is obtained from one of the Babcock and Wilcox boilers belonging to the University, wood being used as fuel. Steam at boiler pressure is used to drive the circulating pump of the leaching plant and the pumps of the two-stage evaporator, but steam for heating purposes is passed through a reducing valve to reduce its pressure to from 5 to 10 lb. per square inch above atmospheric pressure. Low-pressure steam is also supplied to the laboratory for heating purposes and to give a supply of distilled water.

Electric current for motors and lighting is obtained from the mains of the Perth City Council.

Disintegrator, &c.

Raw materials are pulverized in a Van Gelder combined crusher and disintegrator; and the ground material is then raised by means of a "Sirocco" dust-fan through a sheet-iron duct to a "Cyclone" separator mounted above the roof, in which the ground material is diverted

from the air current by centrifugal action and allowed to drop into a storage bin. A tip-truck, running on rails along the loading platform, level with the tops of the leaching vats, is used to charge the latter with ground material taken from the storage bin. Spent material is shovelled over the tops of the vats into shoots leading it outside the building.

Leaching Plant.

Six leaching vats are provided, each vat having a total capacity of about 800 gallons, and holding normally about 6 cwt. of ground bark, and about 600 gallons of water. In each vat, the ground material is supported on a perforated false bottom of copper, covered with hessian. Beneath the false bottom is a steam coil for heating the contents of the vat. By means of suitable pipe lines and valves, water or liquor can be delivered to the top of each vat or drawn off from below. Liquor is moved from vat to vat, and to or from one or other of the various storage tanks, by a steam-driven duplex pump. This pump delivers through a pre-heater, which can be heated by steam when hot liquor has to be supplied to a vat. A second pump (belt driven) is also provided for moving liquor from one part of the plant to another.

Among the questions to be answered with the help of this plant for each kind of raw material to be tried are :—What is the most economical number of leachings per batch of material? And should leaching be done hot or cold? For karri bark four leachings seem likely to be satisfactory. This means that each batch of liquor will be passed in series through four vats filled with ground bark, and each vat full of bark will be leached four times, namely, first, with liquor which is not far from the maximum strength obtainable by leaching, and finally with fresh water. In normal working vats will be filled and emptied in regular sequence.

Storage Tanks.

Five circular storage tanks, with floors and walls of concrete, have been built below floor level. The walls of these tanks form convenient foundations for other portions of the plant. In addition, three circular tanks of corrugated sheet-copper are mounted on the cross beams under the roof. A rain-water tank is mounted on a stand outside one end of the building.

Two-stage Evaporator.

This was supplied by Blair, Campbell, and McLean Ltd., of Glasgow, as were also most of the metal parts of the leaching plant. Evaporation is carried out in two stages or "effects," each "effect" consisting of a steam-heated evaporator below and a separator or spray-catcher above. Liquor from the leaching plant is delivered from an overhead storage tank to a small feed tank, in which the level of liquor is kept constant by means of a float valve. From the feed tank, the liquor is admitted through a regulating valve first into a pre-heater, and from this into the first "effect" where evaporation is begun. It then passes into the second "effect," working at as low a pressure as possible, where evaporation is completed, the limit to which the concentration of the extract can be pushed being governed by the condition that the concentrated extract must not be too viscous to flow through pipes. The concentrated liquid extract is removed from the second "effect" by means of an extraction pump, which delivers it into another of the overhead

storage tanks. The pre-heater and the first "effect" are heated by steam from the boiler, the water formed by the condensation of this steam being drained off through "steam traps." The second "effect" is heated by means of the steam produced from the boiling of the liquor in the first "effect." The steam from the boiling liquor in the second "effect" passes from the separator of that "effect" into a surface condenser and thence into a steam-driven "wet vacuum" pump. In steady running all the condensed water from the evaporator will be available for leaching. It will be seen that, by this arrangement, the latent heat of the boiler steam is used twice over. Under ideal working, for every 1 lb. of boiler steam condensed, 2 lb. of water should be boiled off from the liquor. In actual practice, however, the efficiency is much less, owing to various losses of heat. Also, steam is needed to drive the vacuum and extraction pumps. Since evaporation takes place in both "effects" under reduced pressure, the temperature of the liquor is kept well below the normal boiling point of water. This is important, as some tannins decompose at higher temperatures. The evaporator is designed to deal per eight-hour shift with about 600 gallons of liquor from the leaching plant.

Kestner Dryer.

The object of this apparatus is to complete the evaporation of the concentrated liquid extract down to solid extract, containing not more than from 10 to 15 per cent. of water. A bronze cylinder or drum, heated internally by steam from a boiler, revolves slowly on a horizontal axis. The drum dips into a trough fed with concentrated liquor, and as the drum revolves it picks up a thin film of the liquor, which, after about three-quarters of a revolution, becomes solid extract. The latter is removed continuously from the drum by scrapers, and falls into a hopper where it is broken up by means of an Archimedean screw, and passed into a discharging device, and thence into bags or other containers.

Evaporation can be carried out in the open air, or, alternatively, the drum can be enclosed in an airtight case, which can be exhausted by a suction pump for evaporating under reduced pressure.

Autoclave.

This is a closed vessel of copper, which can be heated by live steam. It is intended, primarily, to get into solution the tannins from marri kino, which requires heat and addition of sodium bisulphite. The autoclave can be worked at atmospheric pressure, or at a wide range of pressures either above or below atmospheric. For working under reduced pressures a "dry-vacuum" pump is provided.

5. Staff.

The staff responsible for running the plant and laboratory are:—Mr. D. Coghill, chemist in charge of tannin investigations under C.S.I.R.; Mr. C. R. Kent, B.Sc.(Hons.), A.I.C., research officer of the W.A. Forests Department; Mr. P. Henryon, technical assistant; Messrs. S. Britton and C. Brown, process hands; and A. Mahon, laboratory boy.

From time to time, University students in chemistry and engineering will have opportunities, especially during University vacations, to assist in running the plant, and thereby to acquire some first-hand knowledge of chemical technology.

The Buffalo Fly Pest.

In a previous issue of this *Journal* (Vol. 1, No. 1, page 55) a short account was given of certain actions that were proposed to be taken in connexion with the further study of the buffalo fly (*Lyperosia* sp.)

Since that time further information has been obtained as to the possibilities of *Hydrotaea dentipes* as a larval parasite. Unfortunately the use of this insect does not appear to be promising, as attempts made in England to breed it in dung have failed.

The inquiries sent to the entomological authorities of India and of British and foreign Colonies and Protectorates in Africa have in general elicited the information that species of *Lyperosia* do not constitute a very serious pest in those localities. Consequently, little work on the genus has been carried out, and the reason why it does not constitute a pest is therefore not known.

When making these inquiries information was solicited under three main headings as follows:—

(*a*) The species, relative abundance, distribution and economic importance of *Lyperosia.*

(*b*) The known parasites and predators of *Lyperosia,* if any, and the possibility of establishing the same in North Australia.

(*c*) The possibility of securing the services of a competent investigator from local staffs to undertake investigations on behalf of, and at the cost of, the Commonwealth.

In the Soudan three species of *Lyperosia* have been recorded, namely, *L. minuta, L. exigua,* and *L. thirouxi.* They are common but unimportant ecto-parasites on animals such as antelopes, camels, horses, &c. In Zanzibar *L. minuta* is considered to be a serious pest of cattle which the natives generally protect in certain seasons by means of sacking. In Pretoria *L. minuta* is not regarded as a serious pest.

By the kindness of Dr. B. Maaesmach, Director of the Veterinary Institute, Buitenzorg, Java, a member of the staff of the Institute, Dr. O. Nieschulz, has been working on a particular phase of the buffalo fly problem for some time. This work, which is being undertaken at the expense of the Council, is directed at the discovery of parasites likely to be useful in the control of the pest in Australia.

Dr. Nieschulz has recently furnished a brief progress report on the results of his work. In October next he is to be transferred to his former position of parasitologist at the Institute for Infectious Diseases in Utrecht, Holland, but he will furnish the Council with a detailed report before he goes.

The following paragraphs are extracts from a translation of his progress report:—

"As the chief object of the work I have endeavoured to ascertain whether ichneumon flies are present in Buitenzorg which could eventually be imported into Australia.

With this object *Lyperosia* pupae were first of all sought in the open. Altogether 635 pupae were found, of which 11 or 1.7 per cent. were infected with ichneumon flies, and as a matter of fact with three

different kinds which in a preliminary way I might designate as Bz.A., Bz.B., and Bz.C. Three pupae were infected with Bz.A., two with Bz.B., and six with Bz.C.

Apart from this, larvae and pupae of *Lyperosia* bred in the laboratory were set free at a suitable place in the neighbourhood of our Institute, the numbers being over 15,000 larvae and 4,000 pupae. After some days 1,790 specimens which had been set out as pupae were found again. Of these not one was infected with ichneumon flies. From those set out as larvae 5,233 individuals which had in the meantime changed to pupae were recovered. Of these 93 pupae or 1.8 per cent. were infected, one pupa with ichneumon fly A, 50 with C, and 42 with a further kind which in the meantime may be named D. The extent of the infection of the pupae found in the open and of the specimens set free by us agreed with one another quite well, being 1.7 on the one hand and 1.8 per cent. on the other.

An attempt was then made to rear in the laboratory the four kinds of ichneumon flies obtained in this way. By far the best results were obtained from the type Bz.C. Experiments were carried out with over 130 females which were brought into contact with over 4,000 fresh *Lyperosia* pupae. Up till now we have obtained from these ichneumon flies 1,074 descendants, 768 males and 306 females. The period of development amounts at the most to two or three weeks, the duration of life of the imago in favorable cases to over a month. The number of progeny amounted to from 5 to 30 females.

Recently yet another series of experiments has been begun in order to ascertain to what extent this kind of ichneumon fly prefers *Lyperosia* pupae to other pupae. The experiments are still in progress, so that nothing can be communicated yet regarding the results. Five experiments were made with B. and A., in which 150 *Lyperosia* pupae were used. Only one pupae was infected, from which seven individuals came out after about three weeks. Bz.A. is a very small species which lays many eggs in one pupa, while the other three species deposit only one egg in each pupa.

Up till now it has not been possible to rear Bz.B. in the laboratory.

With Bz.D. again somewhat better results were attained. In fifteen experiments there came from 1,000 *Lyperosia* pupae, 36 specimens, of which nineteen were males and seventeen females. The time of development amounted to about three weeks. The duration of life in numbers of them was over one month, and the number of progeny from one to four females.

On the ground of the experience so far obtained, I am consequently able to assume that the type of ichneumon fly denoted preliminarily as Bz.C. demands first of all attention from the point of view of its eventual importation into Australia.

In case it is your intention to rear the ichneumon wasp there further, I might just briefly communicate the methods which have been found by me to be the most suitable after a number of experiments.

Freshly caught *Lyperosia* females are placed in a wide-necked flask, the base of which is covered with buffalo or oxen dung. The flasks are caught and allowed simply to stand. After eight days at

least in this climate, the fresh pupae come out, and the dung is then daily subjected to fresh *Lyperosia* pupae. A few of these pupae are then brought into small black glass cylinders or reagent glasses, the bottom of which is covered with dry sand for about half a centimetre. Into these glasses one then brings the ichneumon flies, and the pupae are easily infected if one is really dealing with fresh specimens. The presence of sand appears to be necessary, since without sand no results were attained.

The ichneumon flies themselves can be kept for a pretty long time alive in reagent glasses, if one offers to them sugar water on a little strip of filter paper. The filter paper must be renewed daily.

In Timor, from where probably the *Lyperosia* fly was introduced into Australia, an investigation into ichneumon flies which occur there would be undertaken very willingly with the co-operation of one of the men of your Council. Timor has quite a different climate from Buitenzorg. It resembles more that of Australia, and it is quite possible that ichneumon flies found there may better be naturalized in Australia than those found here."

Geophysical Prospecting in Australia.

(*Statement, May,* 1928.)

A meeting of the Executive Committee, that has been appointed to control the geophysical prospecting investigations about to be commenced in Australia, was held in May, 1928. On that occasion, it was decided to prepare a statement for general circulation, and giving a short account of the various geophysical methods that have been developed, and of the aims and objects of the Imperial Geophysical Experimental Survey. That statement was accordingly prepared, and it is printed below.—Ed.

Within recent years there have been important developments in Europe and America in the application of certain geophysical methods to the location of mineral deposits, and to the determination of important geological structures. Hitherto, however, with the exception of Canada, there has been no comparable progress within the British Empire, and for some time it has been felt by those responsible for the development of the mineral resources of Australia that active steps should be taken to investigate the possibilities of these modern methods of prospecting.

As a result of proposals made to the British Government in January, 1927, the question was investigated by a specially appointed sub-committee of the Committe of Civil Research, of which the chairman, Sir Matthew Nathan, and Sir Egdeworth David were members particularly well acquainted with Australian conditions. The sub-committee was satisfied regarding the value of geophysical methods of surveying, and expressed the view that there are large areas in Australia which are prima facie suitable for trying them out.

In July, 1927, the report of the sub-committee was recommended to the consideration of the Empire Marketing Board, a body which is actively engaged in promoting the economic development of the Empire. The Board approved the two years' programme of geophysical work in Australia, as recommended by the sub-committee, and, on the understanding that the information derived from the investigations should be made available for communication to any other part of the Empire interested, it undertook to provide half of the funds required. The Australian authorities agreed to match this contribution by a similar amount, it being understood that the total expenditure shall not exceed £32,000.

In accordance with the recommendations made by the sub-committee of the Civil Research Committee, a geophysical party entitled the "Imperial Geophysical Experimental Survey" is now being assembled and equipped in Australia, and it is anticipated that work will be commenced in June. The control of the Survey is in the hands of an Executive Committee, which includes members nominated by the States, the Council for Scientific and Industrial Research, the Development and Migration Commission, and the Australasian Institute of Mining and Metallurgy. The field operations will be carried out under the direction of Mr. A. Broughton Edge, who has recently arrived from England, and is now engaged in visiting a number of mining districts with a view to determining their suitability for testing geophysical methods.

Mr. Edge is a consulting mining geologist who for several years has been conducting geophysical exploration by electrical methods in South Africa and Europe. He will be assisted by Dr. E. Bieler,

Associate-Professor of Physics at McGill University, Canada, who has been appointed Deputy Director of the Survey and who is also experienced in the electrical branch of applied geophysics. Dr. N. B. Lewis, of Melbourne University, who has been specially trained in England, will conduct the gravimetric work, and Messrs. S. H. Shaw and J. C. Ferguson, who have been associated with Mr. Edge in his work in South Africa, have also been appointed to the party. Two further Australian physicists are to be appointed, and it is proposed that additional Australian graduates be seconded by the States in order that they may be instructed in geophysical work.

In order that the operations of the Survey may be carried out as effectively as possible, representatives of the various State Geological and Mining Departments have been nominated to act as an Advisory Committee in all questions connected with the selection of suitable areas, and the procedure to be followed in different parts of the country. It has also been decided to form a small consultative committee composed of Australian scientists who from time to time will assist the Survey with expert advice on physical and mathematical matters or in connexion with difficulties which may occur in the interpretation of results.

The geophysical investigations to be made in Australia are concerned, principally, with the gravimetric, electrical, and magnetometric methods, but other processes such as the "seismic" may also be employed during the course of the work. These methods depend on entirely different physical principles, the nature and limitations of which may be briefly outlined as follows:—

The Gravimetric Method.—This is based on the fact that heavy substances, such as most metalliferous minerals, cause a local increase in the force of gravity. By means of a highly sensitive instrument, known as the Eotvos Torsion Balance, the minute variations in the gravitational forces of a district supposed to be mineralized, can be determined. Under favorable conditions the anomalies due to a body of mineral can be recorded with sufficient accuracy to enable the extent of the deposit and its approximate depth from the surface to be computed.

Within recent years the Torsion Balance has proved of special value in locating special geological formations and structural features, with which deposits of economic importance are associated. There are also a number of authentic cases in which the balance has been successful in the direct location of metalliferous ores. At the Hodbarrow Iron Mine in England a body of haematite iron-ore, estimated at 2,000,000 tons, was discovered in 1925 by this means.

As far as prospecting for mineral is concerned, the gravitational method has certain well-defined limitations. Generally speaking, this class of work can not be conducted effectively in rugged or mountainous country, where the disturbances in the normal gravitational field are relatively so great that the minor anomalies due to the presence of an ore-body can not be detected.

The Electrical Methods.—These are numerous, but for practical purposes they may be classified into four main groups:—

1. Equi-potential methods in which direct or alternating current is passed through the ground between points spaced up to a mile or so apart, the distribution of current in the

ground being mapped by means of equi-potential lines. By this means the anomalies due to a conductive body of mineral may be detected.

2. Electromagnetic methods using low frequency alternating currents which are either passed into the ground inductively or through the ground as described in group I. Anomalies in the resultant electromagnetic field are sought for by means of search coils.

3. Radio methods using higher frequencies by means of which waves are transmitted into the ground from an aerial or loop. Anomalies due to the re-radiation of secondary electromagnetic waves are detected by a movable direction finding coil.

4. Spontaneous polarization method.—This is dependent on natural earth currents which are generated in certain classes of mineral deposit.

The Geophysical Survey in Australia will primarily be concerned with the testing of methods which fall within groups 1 and 2, but other processes may be examined at a later stage. These methods are dependent on the electrical conductivity of the mineral to be discovered relative to that of the rock which encloses it. In general it may be said that ore-minerals which possess a metallic lustre, such as the sulphides of iron, copper and lead, certain ores of iron and manganese (also graphite and some anthracites) have a far greater electrical conductivity than the rocks which surround them.

Electrical methods of prospecting possess two important advantages. The work can be carried out in mountainous country—with which so many metalliferous deposits are associated—and the ground can be covered with considerable rapidity. On the other hand they have limitations, particularly as regards the depths to which they are effective in locating mineral, and the difficulties which sometimes arise in districts where conductive substances, other than mineral, are present. Saline waters and shales containing graphite are good electrical conductors, and may give electrical indications which in some cases can hardly be distinguished from those due to mineral.

The Magnetic Method.—This geophysical method depends on the magnetic permeability of the minerals relative to that of the enclosing rocks, and for many years has been an established method of prospecting for iron-ores. Recent developments in instrumental design have made it possible to apply the method to other deposits where the magnetic anomalies are less pronounced, such as salt deposits which actually have a magnetic permeability less than that of the enclosing rocks.

The Seismic Method.—This method is usually applied to the investigation of geological structures rather than to the direct location of mineral deposits. It is based on the elasticity of rock formations and the rate at which elastic waves are propagated through them. Charges of dynamite are fired on the ground, and by means of specially constructed seismographs the time taken for the elastic waves to travel various distances from the blasting point is recorded. With a sufficiency of observations it may be possible to determine the inclination and depth of strata which lie concealed beneath later geological formations.

It often happens that serious difficulties are encountered in applying these methods over old mine workings owing to the empty spaces which exist underground and the existence of metal rails and pipe-lines. The gravitational and electrical conditions in the neighbourhood of such workings are sometimes so complex as to conceal completely any phenomena due to the mineralization of the ground. Geophysical methods may be effective in determining the extent of known ore-bodies and in locating deposits which do not reach the surface. The success of this class of work is entirely dependent, however, on local geological conditions and the class of mineralization in question.

It should be emphasized that in all cases where these geophysical methods are applied to prospecting operations, the observations obtained merely indicate minute differences in the physical properties (density, electrical conductivity, magnetism) of the underlying formations. Such differences may be due to a variety of causes other than the presence of mineral, and their correct interpretation requires a knowledge of physics and geology of a very high order.

In the case of metalliferous prospecting, it should be understood that, as a rule, geophysical methods can only be applied to the location of deposits of the base metals. The precious metals, such as gold, which usually occur in relatively small concentrations within the lode material, can not be discovered by geophysical means, unless some other mineral, such as iron-pyrites or magnetic pyrites, happens to be associated with the gold values in sufficient quantity to give the reef a satisfactory density, electrical conductivity or magnetic permeability as the case may be. Pyritic gold deposits have been successfully discovered in Sweden by this means.

The primary object of the "Imperial Geophysical Experimental Survey," which is now being established in Australia, is to conduct as thorough an investigation of geophysical methods of prospecting as is possible in the time available. The trials will be of an experimental character, and will be carried out in specially selected districts where the type of mineralization and geological conditions are considered to be suitable. When possible, opportunities will be taken to carry out tests over known ore-bodies and in areas where the geological structure has already been fully determined.

As a result of this experimental work, it is anticipated that the Survey will be in a position to provide valuable scientific and practical data regarding the conduct of geophysical exploration for general use throughout the Empire; also that the activities of the party will result in the employment and further development of this class of work within the Commonwealth.

Kraft Paper from Pinus Insignis.

In another part (page 305) of this issue, some information is given as to the attitude of the Council as regards responsibility for statements made in its various publications. In the same place, reference is made to certain statements by the Inspector-General of Forests in criticism of a part of the Council's Bulletin 35, and to a reply by Mr. Benjamin. Those statements and reply are printed below.—ED.

Observations by the Inspector-General of Forests, Mr. C. E. Lane-Poole, on the Council's Bulletin 35.

The research worker, whether he be engaged in the high field of pure research or the more utilitarian applied research, is sooner or later faced with the temptation of wandering from his own subject, down paths where, unhampered by knowledge of the road, he must assume a familiarity with the turnings so that they lead home to conclusions that will help him to add further proof to arguments that he adduces from his research. To give way to this temptation is to court disaster, for the mistakes made may be so serious as to cast doubt on the fundamental research work which forms the main part of the investigation.

An instance of this has occurred in the recent Bulletin of the C.S.I.R., No. 35, entitled, "Kraft Pulp and Paper from *Pinus insignis,*" by Messrs. Benjamin, Somerville, Jeffreys, and Cohen. Benjamin, the leader of the paper research work, will, in this review, be referred to as the author.

If we eliminate section II., pages 6, 7, and 8, the Bulletin is an excellent production, and quite up to the high standard expected of the Paper Laboratory of the C.S.I.R. In section II., however, Benjamin has wandered down the path of forest policy, forest management, and sylviculture, and he has stumbled into many pitfalls by the way.

The bulk of the readers of the Bulletin of the C.S.I.R. are uninitiated in forestry matters. So it has been thought necessary to correct the section in order that no misunderstanding may arise in the minds of those who are interested in the production of softwood in Australia and in New Zealand. We will take the blunders, one by one—

> "But even with the average annual increment indicated by this yield, the economics of pine growing were, until quite recently, not generally considered to be sound, since close spacing with subsequent thinning, or wider spacing and later pruning, would be necessary in order to grow reasonably clear timber. The former could not be done except at great expense in the absence of a market for the thinning, and the latter could only be carried out at a prohibitive cost."

Insignis pine has to be pruned whether it is planted 2 feet or 12 feet apart. So it comes to this—if the thinnings cannot be sold, the trees must be planted more widely apart, so as to eliminate the competition and as much as possible reduce thinning and pruning to a minimum. . . . Plantations 8 x 8 mean 680 trees to the acre; if planted 12 x 12, only 300 trees would fill the same acre. The cost of pitting, planting, and pruning would then be reduced, not as Benjamin says, "only carried out at a prohibitive cost."

"In the case of *Pinus insignis* growing under average conditions on the coastal sandhills of south-eastern South Australia, the mean yield of pulpwood obtainable from improvement thinning at thirteen years has been determined as 600 cubic feet per acre from plantations in which the trees are spaced 8 feet by 8 feet. The records available also indicate that 500 cubic feet per acre could be obtained from thinning at twelve years, and at fifteen years the yield per acre would be 3,000 cubic feet if plantations were clear cut. Thus, the gross pulpwood yield in fifteen years would be 3,500 cubic feet per acre, but it is questionable whether thinning would be worth while financially in plantations that are to be clear-felled at that age, since, without thinning, the average yield at fifteen years is 3,200 cubic feet per acre."

It is difficult to trace the figures of 600 cubic feet of thinnings at thirteen years and 500 at twelve years. Benjamin appears to expect an increment of 100 cubic feet annually per acre in the volume of thinnings. The total mean increment of the plantation is only just over 211 cubic feet, and one-third of this can be taken as a fair estimate of the increment on thinnings.

It is not clear why he should take pains to show that it is uneconomical to cut over the same area twice in three years, first taking thinnings and next taking everything.

"In 1926, the South Australian Government planted 3,000 acres almost wholly with *P. insignis*. It is understood that the working plans provide for the formation of 5,000 acres annually, and this programme was commenced in 1927. It will be seen then, that if the 1926 plantations are managed as a timber-growing proposition, there will be available some 1,500,000 cubic feet of pulpwood per annum from thinnings made in the twelfth year. This is, as will be shown later, equivalent to about 18,000 stacked cords, and approximately 7,000 short tons of pulp. On the other hand, if pulpwood rather than mill timber becomes the principal objective, the output from clear felling 5,000 acres would be in the neighbourhood of 100,000 short tons of pulp per annum; and it is probably safe to say that this would be worth, as the finished article, between £3,000,000 and £4,000,000 sterling, depending on the grades of paper made."

First to understand the arithmetic of converting pulp to wood cords and cords to cubic feet, the following equations are necessary:—

1 ton pulp=2½ stacked cords.

One stacked cord=128 stacked cubic feet=83 solid cubic feet.

(Later, page 17, Benjamin makes it 70-74 cubic feet to the cord, but 83 seems the figure used in section II.)

Benjamin takes South Australia's 1926 planting of 3,000 acres and multiplies it by 500 cubic feet, his estimate of the volume of thinnings available at twelve years, and gets 1,500,000 cubic feet of pulpwood, and states this is obtainable annually, when only a line or so above he has shown that South Australia planted the area of 3,000 acres in one year only, and that 5,000 acres was the annual programme. Let us call "per annum" a slip of the pen. He then converts the 1,500,000 cubic feet to cords by dividing by 83, and gets his 18,000 cords. By dividing this by 2½ he gets, in round figures, 7,000 tons (actually 7,200) of pulp.

Next, he compares this (the production of pulp from the thinnings at a rate of 500 cubic feet per acre from an area of 3,000 acres) with the production from the clear felling of 5,000 acres, and in his multiplication he rounds off the result to the extent of very nearly doubling the figure. For at twelve years the total volume of an acre would be around 2,520 cubic feet or 30 cords of pulpwood or 12 tons of pulp. But 5,000 times that figure is only 60,000 tons, not 100,000 tons.

Assuming that in addition to increasing his areas of comparison from 3,000 to 5,000 acres he has increased the pulping age to fifteen years, then the sum works out as follows:—

$$\frac{3{,}200 \times 5{,}000}{83 \times 2.5} = 15.4 \times 5{,}000 = 77{,}000 \text{ tons of pulp.}$$

which is still a somewhat distant neighbour of 100,000 tons. Next, he converts his 100,000 tons of pulp into cash, and shows it to be worth between three and four million pounds. He has overlooked what he would have to say later on regarding the markets for pulp. For on page 9, he tells us that 18,000 tons is Australia's consumption, and on page 32 that insignis pulp can only be made at a cost of £3.89 more than imported pulp. He does not explain what he proposes doing with the surplus of 100,000 minus 18,000, or 82,000, tons of pulp which cannot be profitably exported. Were the paper not written by a scientist, one would be pardoned for wondering whether the authors were not purposely understating the yield in pulp from thinnings and overestimating the yield and markets for pulp obtained from clear felling of plantations.

> "It is at present being debated whether saw-mill timber or pulpwood should be the objective, but any decision ultimately reached is likely to be largely influenced by consideration of possible developments arising from operations with the same species in New Zealand."

The statement that the objective of the South Australian planting is the subject of debate, is fortunately not in accordance with fact. The 5,000 acre a year planting plan was submitted to the Development and Migration Commission, which in turn submitted it to the Commonwealth Forestry Bureau. The scheme embraces a 30-year rotation for the production of timber. The Forestry Bureau when reporting on the scheme pointed out that the financial arrangement provided only for a ten-year programme, and unless the South Australian Government were prepared to continue the planting beyond this period the scheme was unsound. As a result the 30-year condition was agreed to. To say that the shortening of the rotation to twelve or fifteen years is being now debated shews how far Benjamin has wandered from the narrow path, shall we say, laid down by the lines of his research.

Not content with this dubious excursion into forest policy he plunges into international forest relations and makes South Australia cut her plantations to pulp because New Zealand seems to be growing a surplus of timber more cheaply. Here is what he says—

> "It will be clear that the scale of milling operations made feasible by such extensive planting would in itself tend towards low production costs, but, in addition to this, the actual cost of forming plantations is much less than in Australia, and the timber

matures earlier, so that as a mill-timber proposition the growing of *P. insignis* is very much more attractive in New Zealand than in Australia. There are, indeed, sound reasons for believing that New Zealand insignis pine timber could be landed in Australia 25 years hence at a price appreciably lower than the cost of producing similar grades here."

But what is sauce for the goose is also sauce for the gander, and New Zealand is faced with similar problems to ours in regard to thinnings, and pulp is the only market. So Benjamin is faced with the competition of pulp from the sister Dominion. He gets over it as follows:—

"On the other hand, the relative rates of growth for the same spacing in New Zealand and Australia up to fifteen years are not widely different, and although the initial cost of forming plantations is higher here than in the Dominion, the cost of production is likely to be much the same. Finally, it would be feasible, and comparatively simple, to protect by a tariff a pulping industry supplying practically the whole of the country's requirements of long-fibred pulp, whereas the measure of protection that could be given to a saw-milling industry producing only a fraction of the softwood requirements might prove insufficient to give it the necessary stability."

In other words, pulp can be protected by tariffs, but not timber. This, in spite of the fact that Oregon is 11s. 6d. 100 super. c.i.f. Sydney to-day, and the duty on it is 15s. per 100. Let us examine, too, his "fractions." South Australia's plantations at 30 years, using Benjamin's own figures, mean a volume of 100,000 superficial feet per acre, and represent a total mill volume of 500,000,000 super. feet over 5,000 acres. Allowing a recovery of 60 per cent., this represents 300,000,000 super. feet of sawn timber. Australia's consumption of imported soft woods to-day is around 500,000,000 super. feet, so the output from the South Australian plantations can hardly be regarded as so small a fraction as not to be worth protecting. Again, are we to understand that no other States in Australia are growing soft woods?

Having compared New Zealand's planting with Australia to the latter's detriment, and shown that timber cannot be protected and pulpwood can, he comes to the conclusion—

"Hence it would appear that the planting of pines in Australia is likely, as time goes on, to develop either into a straightout pulpwood proposition or one in which pulpwood rather than mill timber will be the principal product, provided always that the wood is a suitable raw material for the pulping industry."

This prophecy clearly springs not from sound reasoning based on fact, but from that very human tendency to make the wish father to the thought. So much for the unfortunate section II. of Bulletin 35.

What are actually the forestry facts in regard to volume available? One-third of the standing stock requires to be removed from the forest by the fifteenth year, or 1,000 cubic feet per acre. Therefore, 5,000 acres of pine will yield 5,000,000 cubic feet of thinnings, and this volume equals 60,200 cords which would yield 24,080 tons of pulp, an amount not greatly exceeding our present consumption of kraft paper, viz., 18,000 tons.

So there is the position. The establishment of pulp works in South Australia would enable the Government to thin its plantations, and while the price suggested, 12s. a cord, is not a very attractive one, it is far better than having to pay to have the thinnings removed or not thinning at all. On the other hand, it is only fair to those who have dreams of the commercial plantations that have been started here and in New Zealand being utilized for pulp and yielding fabulous profits, to point out that Benjamin's figures show that 30 cords of pulp wood are available at twelve years, and that they are worth 12s. each, so that £18 appears to be the return per acre. Most of the companies that rely on bonds for their capital have made £25 the cost of establishing and maintaining 1 acre of plantation.

In these circumstances, the outlook for the production of pulpwood alone would seem to be far from rosy. Saw-mill timber should, under careful management, pay bank interest on cost of formation and maintenance, and with the sale of thinnings as pulpwood, such plantations should yield better quality timber.

Reply by Mr. L. R. Benjamin.

As is well known to those who have had anything to do with technical research, there are some problems that require for their solution the study of a subject or subjects which, though not always directly bearing upon the actual technical phases of the problem, nevertheless have such an important influence upon the successful commercial application of the results obtained, that consideration of them cannot be divorced from the investigation as a whole. Such a subject has been the silvicultural side of forestry and its bearing upon the question of producing long-fibred paper pulp in Australia.

In the delightful homily which Mr. Lane-Poole reads to the erring research worker, in the opening paragraph of his criticism, he would have us believe that the elements of silviculture are so complex, and the broad principles of forest management so difficult to grasp, that it becomes exceedingly dangerous for any one, who has not been wholly trained as a forester, to venture to express an opinion on these matters, or to draw conclusions from silvicultural data. Entirely disagreeing with this point of view, no apology is offered for section II. of the publication under review.

Let us examine the "many pitfalls," pointed out by Mr. Lane-Poole "down the path of forest management and silviculture," and into which the unsuspecting pulping technologist is said to have "blundered."

Take the first one he mentions.

It will probably be difficult for the reader with the context before him to see why Mr. Lane-Poole takes exception to this paragraph. The author has taken pains to state that "until quite recently" the expense of thinning (in the absence of a market for the produce) and the cost of pruning were such that pine-growing in Australia was not generally considered to be economically sound. By following this up with "In the last ten years, however, there has been a considerable increase in the value of timber, and this, coupled with the predicted future shortage of pulpwood, has led to the planting of pines in Australia and New Zealand on a scale hitherto not attempted either here or in the Northern Hemisphere," surely the inference to be drawn is that the economics

of pine-growing are not now what they were in the recent past. It can only be concluded that Mr. Lane-Poole has misread the statement and unconsciously substituted "can" for the printed "could" in both places in the last sentence quoted by him. The last thing intended was that the reader should gain the impression that "pruning *can* only be carried out at a prohibitive cost." One may, however, be excused for expressing the opinion that the apparent economic possibility of pruning *P. insignis* in this country is so new, and the idea has so filled the forester with hope, that any disparaging reference to it, even though relating to the past, as in this instance, is like the proverbial "red rag to a bull."

In the next paragraph criticized it is asked, what is the basis for the figure "600 cubic feet of thinnings at thirteen years, &c.?" The starting point taken was Mr. Lane-Poole's own estimate of one-third of the total mean increment, and this is scaled down, as dictated by observation, to one-quarter, since not all these thinnings are suitable pulpwood, and because the data upon which the estimate is based was obtained from a small area. In other words, one-quarter the volume of the stand at the end of twelve years is taken as the quantity of suitable pulpwood available from thinning in the thirteenth year. The assessment figures show 2,400 cubic feet as being the total volume of the twelve-year-old stand; one-quarter of this is 600 cubic feet. Similarly, for the other case cited, the volume of the stand to be thinned in the twelfth year being given as 1,850 cubic feet, one-quarter of which is 463 cubic feet, which is taken as 500 cubic feet for the approximation under review. Thus the "blunder" in this case exists because the critic has assumed that all wood cut out as thinnings would be acceptable to the pulpmaker as pulpwood. Brevity, for the benefit of the average reader, has resulted in misunderstanding on the part of the forester; but, knowing that the data had been examined by the author, would it not have been, let us say, charitable to assume that these would have been used, not so much with a view to "purposely understating the yield of pulp from thinnings and over-estimating the yield from clear felling," as to placing the position briefly and concisely before those likely to enter into the business of utilizing this wood for pulping on a large scale?

The next statements criticized occur in immediate continuation of the text last quoted, and they should be considered in conjunction with it.

Once again, brevity is the cause of the forester's dilemma. Yet this could hardly have been anticipated, since no new paragraph occurs after the consideration of clear felling at fifteen years for 3,200 cubic feet per acre, and, moreover, no reference whatever is made to clear felling for pulpwood at an earlier age than this.

There are good reasons for the consideration of thinning the 1926 plantations in the twelfth year. In the first place, Mr. Lane-Poole himself informed the author that effective thinning for pulpwood could be commenced at this age. In the second place, the South Australian Government's offer was for 1,000,000 cubic feet per annum, based on plantations laid down prior to 1926; and it is important, if not vital, from the point of view of a commercial pulping enterprise in which the margin of profit is likely to be narrow on account of high overhead costs on a small production, as in the proposition under consideration, to have some indication as to the earliest date at which expansion could

take place. For similar reasons, it is important that the maximum possibilities be considered as well. Hence the allusion to the possibility of developing a relatively large industry by clear-felling the 5,000-acre plantations as they reached the age of fifteen years. And the reason why fifteen years was taken as the clear-felling age is that *P. insignis,* as grown in the south-east of South Australia, is then of a size most easily dealt with by the machinery regularly employed in the pulping industry.

As to the figures on yield, &c., criticized by Mr. Lane-Poole, there is very little at fault here, as will be seen from the following.

In the first place, it should be pointed out that the figure 7,000 should read 9,000. This is due to a typing error which found its way into the printer's hands, and the author, unfortunately, had no opportunity of correcting the proofs.

The basis for calculations given in the text is as follows:—

1 stacked cord=128 cubic feet.

128 cubic feet *P. insignis* in the bark=72 cubic feet solid wood. (See page 17 of the *Bulletin.*)

72 cubic feet solid barked wood=0.9 cord.

Therefore, for this size pulpwood, 80 cubic feet is the solid contents of 128 cubic feet stacked.

0.9 cord=990 lb. total pulp (page 24 of the *Bulletin*), whence 1.8 cords=1,980 lb. pulp.

Taking barking loss 10 per cent., which is feasible when handling 50 cords or more per day in drum barkers followed by partial knife-barking—

2 cords wood in bark=1,980 lb. pulp, i.e., a little under 1 short ton (2,000 lb.).

Hence, in a general outline such as this, it is sufficient to take 80 cubic feet standing wood as equal to 1 cord stacked, and 2 cords of this equal 1 short ton of pulp.

It will be seen from this that the figure 9,000 short tons for the yield from thinning the 1926 plantations is not far out (400 tons). "Per annum" in the text relating to these thinnings is obviously a "slip of the pen," which would hardly have been missed if the author had had the opportunity of reading the proofs.

On the clear-felling side, 5,000 acres at 3,200 cubic feet per acre gives, on the above basis, 200,000 cords, equal to 100,000 short tons of pulp.

Now a word on the markets for pulp from insignis pine. One is led to understand that the forester is so accustomed to thinking into the future that it almost becomes second nature with him. Why, then, does not Mr. Lane-Poole project his mind into the future when it comes to criticizing a set of statements that so obviously do not refer to the present? We are considering probable markets in Australia fifteen years hence, when it is expected that the present population will have considerably increased. Is it, then, unreasonable to expect that the

consumption of paper will also increase? It is pretty safe to say that 40,000 tons of kraft paper would be the minimum requirements of the Commonwealth in 1943. As for the remaining pulpwood, equivalent to 60,000 tons of pulp per annum, that would almost certainly find its way into bleachable pulps, sulphite, and sulphate, for printings and fine papers. This aspect is indicated by the last phrase of the extract quoted ("depending on the grades of paper made"), and also more explicitly lower down on page 8, in the phrase, "a pulping industry supplying practically the whole of the country's requirements of long-fibred pulp." There is, therefore, no need to consider exporting pulp on the basis of clear-felling 5,000 acres a year. As to the cost of making pulp, it will be clear to most readers that the overhead and labour costs on a production of 20 tons per day would be very considerably higher than, for example, on a 200-ton-a-day plant. (See page 30.)

So much for the "blunders" on yield, &c., which, from an obviously cursory examination of the publication, Mr. Lane-Poole has chosen as material for his criticism. After reading the closing sentence, in which he graciously gives the "scientist" the benefit of the doubt, one begins to wonder whether this criticism is not in the nature of a heresy hunt.

The only excuse offered in regard to the statement concerning the objective of the South Australian planting programme is that the period intervening between the time of writing and the time of publication of matter connected with an investigation may be sufficient to render certain comment out of date. Since, however, it is not denied, the assumption can be made that the relative merits of growing pine for pulpwood on a short rotation or for mill timber were debated, and, in any case, probably most readers will agree that comment along the lines contained in the extract quoted is not by any means extraneous to an investigation into the commercial feasibility of pulping this timber in Australia.

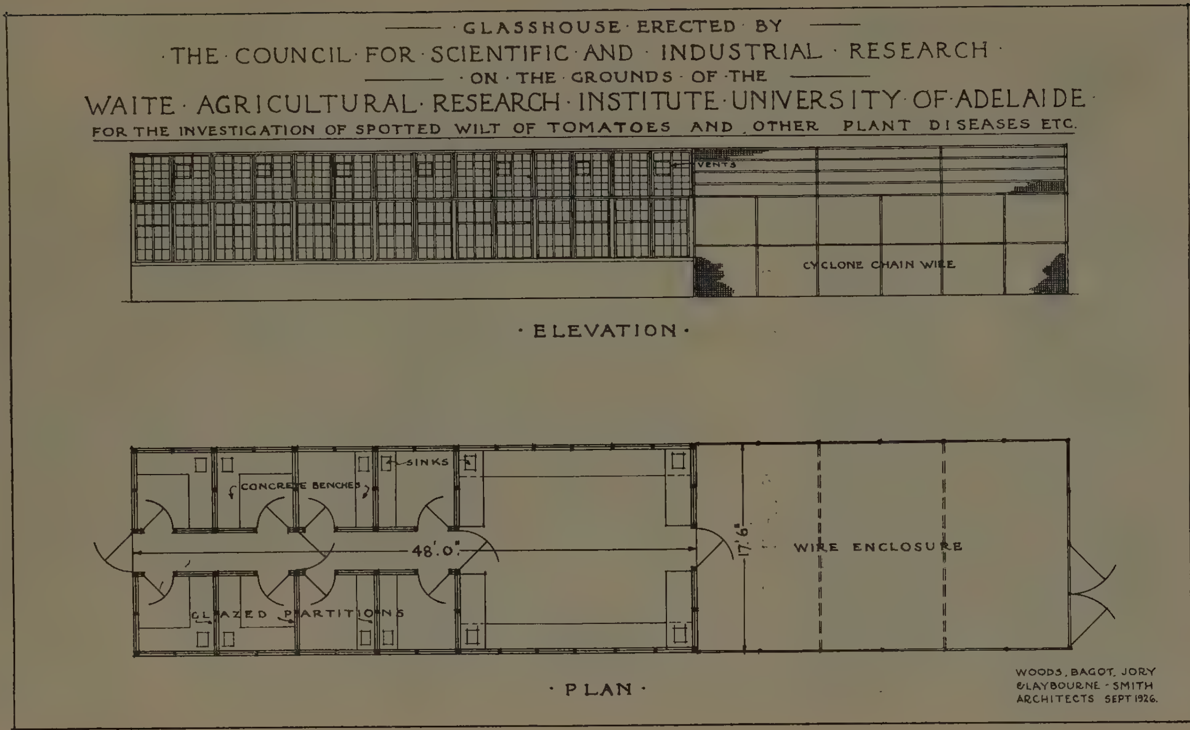
In regard to the comparisons with New Zealand, it is, of course, a fact that thinning must be done in growing mill timber here or in New Zealand. It seems likely, too, that, since the timber matures earlier, and formation and other costs are lower, they in New Zealand could afford to dispose of thinnings as pulpwood for less than we in Australia. This, of course, would result in a lower cost of wood per ton of pulp, so that, other things being equal, the cost of producing pulp would be lower. Similarly for clear-felled pulpwood grown on the short rotation. (Note that "cost of production" in the text after "Dominion" should read "cost of conversion.") There is, however, not much fear of competition from the sister Dominion given a fairly extensive scale of operations in Australia, e.g., 60,000 tons of pulp a year, since the latter would almost certainly be converted into paper at the point of production. This would not only eliminate the handling, storage, and re-slushing costs on lap pulp, but the paper made from the fresh pulp would be superior to that made from dried-out pulp; and, finally, paper is already protected by the tariff on a basis that would scarcely allow of competition from imported Dominion paper costing nearly as much to make.

The position as seen by the author in this matter is that, when we are in a position in Australia to make long-fibred pulp at the rate of 200 tons a day at one place, there is not likely to be much danger of successful competition from outside sources.

Mr. Lane-Poole's reference to the present duty on Oregon cuts both ways. Was not this duty imposed largely to protect the hardwood milling industry, which supplies but "a fraction" of our total requirements of timber, and is this industry flourishing, or even stable? And in dealing with "fractions," if Australia's consumption of imported softwoods is 500,000,000 super. feet to-day, may we not require, say, three or four times this volume when we have populated our country and commence cutting our *P. insignis* plantations 30 years hence? Taking the lower figure, 1,500,000,000 super. feet, South Australia's quota towards this would be 20 per cent., and it would appear that if the other States do not move any faster in the next few years than they have done in the recent past, their quotas are not likely to increase the fraction to a marked extent.

As to the wish that, "the planting of pines in Australia, &c.," is father to the thought in the author's mind, the latter would leave to the reader to conclude whether the boot is not on the other foot, and whether the forester's anathema against clear-cutting, as pulpwood, forests with such "expectation values" as these appear to possess, is not responsible for Mr. Lane-Poole's criticism, which, if not wholly justifiable, is at least vigorous.

PLATE 1.



C.8807.

PLATE 2

GLASS-HOUSE AT THE WAITE AGRICULTURAL RESEARCH INSTITUTE

Fig. 1.—Glass-house and Wire Enclosure from Western side.

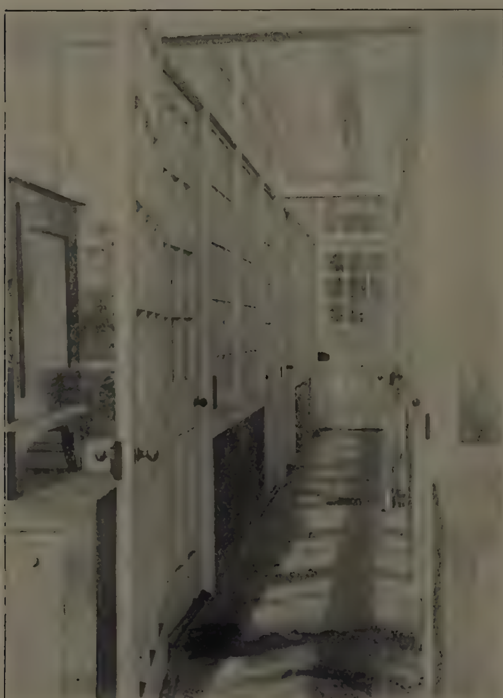


Fig. 2.—Central Corridor showing Doors of small Compartments.

PLATE 3.

TANNIN EXTRACT PLANT ERECTED IN THE GROUNDS OF THE UNIVERSITY OF WESTERN AUSTRALIA.

General View of Plant.

The larger building on the left houses the main plant. The smaller building on the right is the laboratory and office

PLATE 4.

INTERIOR OF TANNIN EXTRACT PLANT.

Two-stage Evaporator in left background; Dry Vacuum Pump and Circulating Pump in foreground.

Kestner Dryer (open) on left, and Two-stage Evaporator on right

NOTES.

Responsibility for Statements in Council Publications.

The question of responsibility for the accuracy of scientific work and conclusions recorded in the Council's Bulletins and Pamphlets has recently been before the Executive Committee. Writing about one of the latest issues a prominent business man has expresed the view that an important publication " . . . purporting to emanate from the Council for Scientific and Industrial Research should be under the strict supervision of that body, bear the signature of the Chairman or the Chief Executive Officer, and not be left to the judgment or caprice of . . . the authors." If the signature of either of these officers is to be of significance in such a place it must be taken to imply a guarantee of the correctness of the work and conclusions set out in the publication. Any such "guarantee" would involve a rather amazing assumption of omniscience which, it is to be hoped, would be quite beyond any members of the Council who might happen to occupy the positions of Chairman or Chief Executive Officer. It is the Council's duty to secure the best men available under prevailing conditions to take charge of its several Divisions. These men and their colleagues must carry full responsibility for the work which they place on record. They, and not the official heads of the organization, are entitled to receive, in enhanced reputations and in other ways, the rewards of the excellence of their work; hence, too, they must carry responsibility for errors, if any occur. Members of the Council can not, and should not, attempt to influence the conclusions of their research men. Freedom, coupled with individual responsibility, is essential if scientific men are to give of their best in research work. The Executive Committee desires to make its position quite clear in this respect. It confidently looks to its heads of Divisions for properly conducted work and accurate reports concerning it. Its duty is to obtain men worthy of that confidence, and having obtained them, to repose in them the trust that any scientific body must extend to its staff until such time as that trust is proved to be unjustified. What authority the Council's publications possess must be based on facts scientifically ascertained by its investigators, and not on the signatures of individuals who have taken no part in the investigations. This attitude will be thoroughly intelligible to scientific men.

In common with the publications of all scientific organizations, those of the Council are open to challenge from workers who consider them to be inaccurate in matters of observation, experiment, or judgment. Certain statements in Bulletin No. 35 on kraft pulp and paper from *Pinus insignis* are regarded by Mr. C. E. Lane-Poole, Commonwealth Inspector-General of Forests, as open to criticism. We publish in this issue an article by him, and also the reply of Mr. L. R. Benjamin who was in charge of the Council's paper-pulp work at the time when the investigations recorded in the Bulletin were carried out.

A.C.D.R.

Scientific Research in Japan.*

Recently, while attending the Pan-Pacific Science Congress, the President of the National Research Council had an opportunity to make a study of the situation in Japan. As is well known, no nation in modern times has so rapidly risen from a position of comparative obscurity to be one of the productive industrial nations of the world. Due to causes which are well known, Japan has definitely set herself the task of re-organizing her industrial life on modern scientific lines. There is, perhaps, no other country where the same intensity of purpose on the part of educational institutions and government departments is being applied to ensure the industrial success of the nation.

In the first place, a complete system of vocational schools strategically placed in industrial centres of the country has been established for the purpose of preparing men for handling the machinery of industry. It will probably be ten years yet before the nation will receive the full benefit of the money being spent in this connexion, but the Japanese are a people who take a long view.

In the second place, the six Imperial Universities of Japan are supported by the State, and are organized for both undergraduate and graduate work on thoroughly modern lines.

In addition, there are 69 specific research institutions in the country working on the problems of industry and agriculture, of which 45 are definitely under Government auspices, being mainly centralized in the national capital. In the 69 institutions which cover every phase of national industry, there are employed 1,102 experts, to whom are attached 2,214 scientific assistants, making a total of 3,316 specialists engaged in the solution of the technical problems of industry and agriculture. In the 45 government and public institutions there are employed 681 expert research men with 1,674 assistants. In addition, every year 300 of the most brilliant graduates of the Universities are selected and sent abroad at the expense of the Government for foreign study, mainly to Germany, Great Britain, the United States, and France, in order that the nation may be kept constantly in contact with the most recent advances in science and technology. The cost of all this to the country is very great, but they are convinced that it will ultimately be returned one-hundred fold in national dividends. The travelling scholarships alone are costing the nation approximately £120,000 a year.

Without question, the industrial nations of the West will in the near future find the Japanese nation one of their strongest competitors in the markets of the world, while nations having a surplus of food products will find a ready market to enter, but on a strictly competitive basis.

The Barrier Reef Expedition.

The Great Barrier Reef of Australia extends from Harvey Bay, 12 miles north of Brisbane, in latitude 25 deg. S. to New Guinea in latitude 9 deg. S. Its distance from the mainland varies from 100 miles at its extremities to an average of not more than 30 miles at

* Extract from "Report of the President and Financial Statement, 1926-27," National Research Council, Dominion of Canada, p. 21.

its centre. It was first explored by Captain Cook, but the first systematic survey was made by H.M.S. *Fly* and *Bramble* in 1842-46, when it was shown that some of the Barrier consisted of linearly extending reefs, while in other places it was represented by a series of ring or atoll-shaped structures.

In the years that have elapsed since that time various investigators have studied some of the many scientific problems connected with the reef, but comparatively little attention has been given to it from the biological point of view. Of late years scientific work has been carried out by, or under the auspices of, an Australian committee known as the Great Barrier Reef Committee. Some of the results obtained by that Committee were published in July, 1925, in the *Transactions of the Royal Geographical Society of Australasia* (Queensland branch), and in January, 1928, in the *Report of the Great Barrier Reef Committee.*

Some two years ago, the Committee invited British scientists to take an interest in the problem, and, as a result, at the meeting of the British Association for the Advancement of Science held at Leeds in September, 1927, a Committee, with Sir Matthew Nathan as chairman, was appointed to organize the Expedition which has now reached Australia. Its leader is Dr. C. M. Yonge, Balfour Student of the University of Cambridge. Mr. F. S. Russell, of the Plymouth Marine Biological Laboratory, will be a member and, in addition, some eight or nine other scientists, such as zoologists, chemists, hydrographers, botanists, and geographers will be included. Arrangements are also being made for the attachment of Australians to the party.

The purposes of the Expedition are to examine a sector of the reef off Cairns from the shore to the open ocean, marking down the associations of plants and animals, studying the food and capacity of lime deposition of the same, and all such other matters as concern the formation and growth of that part of the Reef. Work will be undertaken by a shore party and by a boat party for the purpose. The information being sought by the Expedition is essentially of a scientific nature, but the economic possibilities of the reef will not be overlooked. In the words of Dr. Yonge, " The Great Barrier Reef is immensely rich in life, and should prove a source of vast wealth if properly exploited, and for this a thorough biological survey is the essential preliminary."

A large part of the necessary funds for the Expedition were subscribed by scientific societies and individuals. The British contributions of this nature totalled some £2,000, including contributions from the Royal Society of London, the British Association for the Advancement of Science, and the Zoological Society of London. In Australia £1,000 was collected by the Barrier Reef Committee, and the Australian Association for the Advancement of Science provided £200. Subsequent to these contributions being made the Empire Marketing Board and the Commonwealth Government agreed to provide the sum of £2,500 each, and thus the Expedition became possible.

Proposed Citrus Preservation Experiments.

For some time past, those connected with production of citrus fruit in Australia have felt that the industry could be expanded considerably if a means could be discovered whereby the fruit could be made

available the whole year round, and whereby its condition could be maintained for a sufficiently long period to render its export to other countries possible. Many attempts aimed at the development of such a process have been made.

A recent development is the decision that has been reached by the Victorian Department of Agriculture, the Victorian Railways Commissioners, the Victorian Central Citrus Association, and the Council to co-operate in a series of experiments. The work is to be controlled by a committee of the Council consisting of the following:—

Associate-Professor W. J. Young (Chairman), University of Melbourne.

W. B. Bracher, Esq., Victorian Railways.

Captain Halhed, Victorian Citrus Growers' Association.

J. Hepburn, Esq., Chief Engineer and Works Manager, Victoria Dock Cool Stores.

W. Ranger, Esq., Manager, Committee of Direction of Fruit Marketing, Queensland.

F. M. Read, Esq., Department of Agriculture, Victoria.

The Committee held its first meeting on the 19th June, and drew up a programme of work embracing the careful, supervised handling of the fruit from the trees to the final packing, and aiming at the elimination of all factors, other than the preservative method employed, which might influence the keeping qualities of the fruit. These factors include the location, the history and nature of the soil and trees, the age of the trees, methods of irrigation, the nature and extent of manuring, the size of trees, methods employed in picking, handling, grading, packing, transport and storage, &c. The object of the work will thus be a study of the effect of different preservative treatments.

Subject to the necessary equipment being available in time, it is expected that some experiments will be conducted in the early spring. The work has been rendered possible only by the granting of facilities by all the co-operating bodies.

Liver Fluke: Possible Difficulties with the Carbon Tetrachloride Treatment.

A short time ago, the Council for Scientific and Industrial Research published a pamphlet on liver fluke disease of sheep by its Parasitologist, Mr. I. Clunies Ross, B.V.Sc. The carbon tetrachloride treatment dealt with has, during the past year, been widely adopted throughout Australia.

In addition, many stockmen have tried the drug as a curative agent in cases of stomach worm infestation of sheep and cattle. Though the employment of carbon tetrachloride in the amount recommended of one cubic centimetre for sheep may be adopted with perfect safety in the great majority of cases, nevertheless reports are received from time to time of ill effects, and even some mortality following its use.

The Council therefore desires to publish some further comments by Mr. Ross on the subject as follows:—

It is very doubtful whether such mortality in all cases is due to the use of the pure drug, since it would appear that sometimes impure preparations of carbon tetrachloride have been employed, or it has been given in some form other than mixed with liquid paraffin or in capsules. Also, it is probable that sometimes more than the correct dose has been accidentally given. After making due allowance for these factors, however, it must be recognized that in a proportion of cases neither the purity of the drug nor the method of administration was at fault, so that it becomes necessary to determine why it is that in certain instances the drug may become toxic and how such ill effects may be prevented. It has been found that in America similar cases of carbon tetrachloride poisoning may occasionally occur in man and animals, and research has shown that dietetic factors exert a very powerful influence on the effects produced by the drug, and that the amount of calcium in the diet is of paramount importance in this connexion. Where animals have been fed on a diet deficient in calcium, severe symptoms of poisoning may follow the administration of even small quantities of carbon tetrachloride, while other animals on a diet which contains an adequate amount of calcium may be unaffected by very large doses. The fact that much grazing land in Australia is known to be seriously depleted of necessary mineral constituents makes it likely that here, also, lack of calcium plays an important part in the production of these isolated cases of carbon tetrachloride poisoning. It would be expected that, were calcium deficiency the cause of this mortality, ewes and young stock would be more likely to be affected than would wethers, since in the former classes of animals there is a much greater drain on the available calcium in the system. It is perhaps significant that both in Australia and elsewhere many of the more serious cases of carbon tetrachloride poisoning have been in ewes.

Fortunately any ill effects resulting from calcium deficiency, and following the use of carbon tetrachloride may be prevented by adding calcium in licks. Calcium may be satisfactorily given in licks in the form of powdered calcium carbonate or in the form of bone meal, the latter having the advantage that should phosphorus deficiency also occur this will simultaneously be corrected. Wherever there is any suspicion that mineral deficiency of the pastures is present, calcium should be fed for at least a week before treating sheep or cattle with carbon tetrachloride, and this is especially necessary before treating ewes or young growing stock. Since it is known also that hand feeding may in certain instances influence the effects of the drug, it is recommended that all hand feeding of concentrates should be discontinued for one week before dosing. As an additional safeguard, small numbers of sheep of different classes and from different paddocks should be treated with carbon tetrachloride, and the results observed some days before treatment of the whole flock is carried out. An account of any particulars of ill effects following the use of carbon tetrachloride, especially in regard to the dose and form in which the drug was given, the age and sex of animals affected, the existence of known mineral deficiency in the pastures, and the nature of any hand feeding and licks given prior to dosing, would be greatly appreciated by the Veterinary Parasitologist to the Council for Scientific and Industrial Research, the Veterinary School, University of Sydney.

The Colonial Agricultural Service.

Of late years a considerable amount of attention has been given to the organization and co-ordination of the operations of the agricultural services of the Empire. In the older established British settlements, namely, the Dominions, these Services are naturally now well organized, but much can still be done in the direction of co-ordination and the pooling of information obtained more particularly as the result of research. This whole matter was discussed at length at the recent (October, 1927) Imperial Agricultural Research Conference.

The needs of the non self-governing Colonies, such as Nigeria, Malaya, Kenya, Jamaica, &c., however, have by no means been overlooked, and recent considerations are outlined in a report* that has just reached Australia. The report draws attention to the fact that the welfare and progress of agriculture is to-day the most vital concern of every Colonial Administration, as the prosperity of the people, the trade, and the revenue of each Colony is mainly dependent upon its agricultural production; that agriculture is indeed the main industry of the Colonial Empire; and that on the efficiency of its agriculture all social and economic progress depends.

The trade of the Colonies in question is rapidly expanding, amounting in 1906 to £157,000,000 per annum, and twenty years later to £485,000,000. Despite the above expansion, it is considered that the industries concerned are only in their infancy, depending as they do on the activities of some 50,000,000 people sparsely scattered throughout large territories. The full development of agricultural production in the Colonies is apparently yet to come.

The Committee appointed by the Secretary of State was set up for the purpose of formulating a practical scheme for the creation of a Colonial agricultural scientific and research service available for the requirements of the whole Colonial Empire. It endorses previous recommendations that a Colonial Advisory Council of Agriculture and Animal Health be set up, and recommends that under this Council there shall be two committees to be called the "Agricultural Committee" and the "Committee of Animal Health." It recommends that the functions of the Council and the Committees should be to advise on the following matters:—

(*a*) The supply and training of specialist and agricultural officers for the Colonial Agricultural Services, in conjunction with the recruiting authorities of the Colonial Office.

(*b*) The establishment of Central Research Stations and general guidance of their work.

(*c*) The efficiency and general well-being of the unified Colonial Agricultural Service, including such advice upon the Agricultural Services as the Secretary of State or Colonial Governments may desire.

(*d*) The collection, collation, and distribution of scientific and agricultural information in fields not covered by other agencies.

(*e*) Main research policy in the Colonial Empire.

* Colonial Agricultural Service—Report of Committee appointed by the Secretary of State for the Colonies. H.M. Stationery Office, 1928.

(*f*) The representation and collaboration of the Colonial Empire as a unit in Imperial schemes of research and in Imperial Bureaux and Correspondence Centres.

(*g*) The general progress of agriculture and food production in the Colonial Empire.

The Committee goes on to recommend that a Colonial Agricultural Service be formed with two wings, namely, a special or research side, and an agricultural or administrative side. In other words, if effect is given to this recommendation it will mean that the present Agricultural Services of the Colonies will be welded into one large and unified service.

The cost of the re-organized and single service is estimated by the Committee to be £127,000 per annum. The Empire Marketing Board has agreed to make substantial contributions to the above cost if the scheme is put into operation.

Geophysical Prospecting in Australia.

The organization of the party that is to conduct investigations in Australia on geophysical prospecting, and referred to elsewhere (see page 292), is now practically complete. Mr. Ferguson arrived in Melbourne early in June, and was followed a few weeks later by Dr. N. B. Lewis. Dr. Bieler arrived in the second week of July. Mr. S. H. Shaw, the other of Mr. Edge's former Rhodesian assistants, left England on the 23rd June. In addition to Dr. N. B. Lewis, another Australian graduate—Mr. E. L. Blazey—has been appointed to specialize mainly on the electrical methods, although each member of the party will be given an opportunity of becoming conversant with all the methods that are actually used. The appointment of still another Australian, to specialize chiefly on magnetic and gravimetric methods, is still under consideration.

A commencement has already been made with the field operations. An area at Anembo near Queanbeyan, New South Wales, is being studied by electrical methods, and at Gelliondale, in Gippsland, Victoria, the torsion balance is being used in an attempt to determine the boundaries of certain brown coal deposits.

Since the arrival of Mr. Edge, certain factors likely to cause complications have become more fully apparent. In the first place, underground saline waters, being fairly good conductors of electricity, are liable to cause disturbances, the effects of which are most difficult to determine and to differentiate from the effects of conducting ore bodies. Further, the existence of mine workings with the necessary pipe lines, truck rails, &c., also creates disturbances. These, however, do not exist in virgin country, for the prospecting of which the methods are perhaps more suited. On the other hand, in the light of the further information that is now available, it appears that the methods are probably capable of application to Australian conditions in ways to which little previous consideration had been given. For instance, it is possible they might be applicable in the search for hidden gold or tin alluvial "leads."

Mr. Edge is now making a careful search for other areas likely to be suitable for the special work under consideration. In this he is being afforded most valuable assistance by the authorities of the various State Departments of Mines and Geological Surveys who throughout have evinced a keen interest in the operations.

Scientific Research: Resolution of Chambers of Commerce.

"Through the agency of the Association of Chambers of Commerce of Australia, the Council has received the following copy of a resolution carried at the eleventh Congress of Chambers of Commerce of the British Empire, held at Cape Town in October, 1927.—Ed.

"Whereas the work of National Research is a record of unparalleled achievement to the advantage of the British Empire during the Great War, when the intellectual and industrial forces were unified with one object, and were pooled to the advantage of the allied powers.

And whereas the work of National Research has been aided by comparatively trivial grants from some of the Dominions within the British Empire.

And whereas competition in the realm of National Research should be stimulated by grants to Universities and Industrial Laboratories to promote co-operation to further the development of the national resources of each country within the Empire.

Therefore, be it resolved—

That the Federation of Chambers of Commerce of the British Empire urge upon the Governments of the various parts of the British Empire the urgent necessity of establishing such national research institutes with sufficient financial appropriations to enable them to function in the most modern and scientific way, or in the case of such countries of the British Empire as have already established in any degree such institutes, that the Governments of these countries be urged to place at the disposal of such institutes sufficient financial appropriation to enable them to undertake researches with the object—

(*a*) Of improving the technical processes and methods used in the industries, and of discovering new processes and methods which may promote the expansion of existing industries or the development of new industries;

(*b*) of assisting in the development of the natural resources of the country; and

(*c*) of promoting the utilization of the waste products of industries.

And further—

That the result of such investigations and researches made by any country within the Empire be placed, in so far as may be expedient and practicable, at the disposal of all other countries in the Empire who are in a position to make use of them, in the belief that the benefits accruing from such Imperial co-operation will be of the greatest possible advantage to the whole Empire both commercially and from the point of view of mutual protection."

The Chemistry of Wine-Making.

In response to requests from Empire producers for information on recent developments in wine-making, the Empire Marketing Board recently arranged for Professor J. T. Hewitt, D.Sc., F.R.S., to visit France, Germany, and Algiers, and to report on the subject. Printed copies of Professor Hewitt's report* have just become available in

* "The Chemistry of Wine-making, a Report on Oenological Research," by J. T. Hewitt, M.A., D.Sc., Ph.D., F.R.S., Empire Marketing Board, March, 1928.

Australia. In the preface, it is stated that "There is encouraging evidence that the British public is beginning to appreciate the fact that the Empire can and does produce agreeable wine of sound quality and reasonable in price. . . . Oenological research is, however, capable of very considerable developments, especially in regard to the newer wine-producing areas; and the effect on the resulting product of different combinations of the various climates, soils, stocks, and methods of culture and manufacture have as yet by no means been fully explored."

The report is much too voluminous and contains far too much information to be capable of having justice done to it in a short abstract. The following order has been adopted in dealing with the subject-matter:—The influence of soil and climate on the vine, the composition of grapes and nuts, yeast and alcoholic fermentation, standard processes for making wine, additions to must, modifications in the fermentation process, mechanical improvements, the bouquet or flavour of wine, and the utilization of by-products.

A short abstract of the portion dealing with the effect of soil and climate is given in the following paragraphs:—

The composition of grapes and, consequently, the flavour and quality of the wine, are greatly influenced by the chemical nature and physical condition of the soil. Grapes produced on siliceous soils give light wines with small alcoholic content, whereas the wines made from grapes grown on clays are more coloured, more alcoholic, and richer in tannin. These wines may, at first, be somewhat hard, but they generally mature after several years. From calcareous soils, wines of considerable bouquet are obtained, the lime content of the soil and the bouquet of the wine running parallel to one another. For instance, the wines of Champagne owe their extreme distinction to the chalk in which the vines grow. The inimitable perfume of the Champagne brandies of Cognac is the more pronounced, the greater the calcareous content of the soil.

According to Chancrin, the best constituted wines are given by soils containing sand, clay, and lime. These wines are alcoholic; they possess delicacy, bouquet, and colour, and keep well. When soils are too rich in humic substances, the wines which are produced are coloured, common in character, rather coarse, and of poor keeping qualities.

When the physical condition of the soil is considered it is found that pebbly soils give the best grapes, while reddish soils produce the best red grapes, and light soils are the most suitable for white grapes. It appears that, although the red colouring matter of the grape is of organic composition, soils rich in ferric oxide yield highly coloured wines.

A few examples, quoted by Chancrin, serve to illustrate the influence of the soil on the quality of wine produced. The variety *Gamay* gives wine of quality when grown on the porphyritic slopes of the Beaujolais, but when reared on the calcareous marls of Burgundy, the wine produced is of ordinary character. As a further example, the variety *Pinot* furnishes celebrated wines when grown on a calcareous soil in Burgundy, whilst ordinary wines are produced by vines of the same variety growing on a compact clay soil. The presence of lime in the soil is necessary for the development of the particular flavour which is so much appreciated in the wine of Burgundy,

but from *Pinot,* grown on calcareous soils in the warmer Midi, the wine is disagreeable and the particular flavour becomes grossly exaggerated. It is apparent that certain varieties of grapes are more suited than others to particular climates and soils.

With regard to the effect of climate, as a general rule, it is found that grapes grown in temperate climates show a greater ratio of acid to sugar than do those raised in warmer regions. The smaller the amount of sugar in the grape, the lower will be the alcoholic strength of the resulting wine, and it is in the warmer climates that one finds the greatest production of sugar. On the other hand, it must not be assumed that the percentage of sugar is necessarily higher in a must produced from grapes grown in a warm region. A deficiency of acid is frequent in grapes grown in warmer climates, and if the ratio of acid to sugar is too low the course of fermentation is adversely affected.

The Flying Fox Problem.

A most serious menace confronting fruit-growers in Queensland and New South Wales is that constituted by large fruit-eating bats commonly known as flying foxes.

There are five species in Australia, the commonest by far being *Pteropus poliocephalus.* Nocturnal in habit and very gregarious, these animals live in large camps of hundreds of thousands of individuals. They migrate according to season and food supply, but usually return to the same camps in successive seasons. In the day-time they cling to the branches of trees in dense numbers; they are restless and alert, and a single gun shot will put the whole camp in flight. At night they depart in search of food such as fruit, berries, eucalyptus flowers, and honey. They are particularly fond of cultivated fruit, and the damage they can do in an orchard in one night is appalling. The amount of fruit eaten is relatively small, but the ground is strewn with material which has been merely nibbled or claw marked.

Many obvious methods of destruction have been tried. Shooting is expensive. Strychnine poisoning in the orchard is successful to an extent. Poison gases in the camps are not effective because of the timidity of the bat, and it is almost impossible to give a lethal dose before it takes wing. Infection with *Bacillus typhi-marum* is said to have cleared Samoa of the pest some years ago, but the report has not been verified, and it is understood that Samoa is still badly infested. A small flammenwerfer has been tried, but besides being dangerous and expensive it is not suitable for general use.

All these and other methods have been more or less successful in killing the creatures, but in every case the scale of possible operations is hopelessly inadequate. Wholesale slaughter must be achieved if the pest is to be minimized or even merely kept from increasing.

Through their Departments of Agriculture the State Governments of Queensland and New South Wales have now agreed to co-operate with the Council in a systematic biological study of those species of flying fox which are a pest in Australia. For that purpose an investigator is to be appointed for a period of two years at a salary of £600 per annum. He will be required to study the biology of the

animal from the point of view of its possible control. He will also be required to seek quantitive evidence as to the ravages of the animal and to obtain as accurate an estimate as possible of the losses it is causing to the fruit and other industries of New South Wales and Queensland. It is hoped that once further details of the biology of the pest are known further possible methods of its control will become obvious.

Applications for the position of investigator close on the 1st September.

The Dingo Pest in Australia.

By Max Henry, Esq., D.S.O., B.V.Sc., M.R.C.V.S., Chief Veterinary Surgeon, New South Wales Department of Agriculture.

The possibility of controlling the serious dingo pests in Australia by means of the dissemination of disease has been put forward on several occasions in the past. The views of Mr. Max Henry, Chief Veterinary Surgeon of the New South Wales Department of Agriculture, in regard to that suggestion are given below. Incidentally, it might be mentioned that members of the British Distemper Research Committee are of the same opinion as Mr. Henry.—ED.

The question of utilizing disease as a means of eradicating animal pests has often been suggested and many times tried, but so far there is no instance on record in which a successful issue has been obtained. Such successes have been reported, but reports have not withstood the criticism of a closer investigation. To be successfully employed in the eradication of a noxious animal a disease must comply with certain criteria. In the first place, it must be a disease to which none of the domesticated animals or birds, or desirable wild animals or birds, are susceptible; secondly, it must spread rapidly by direct and indirect contact; thirdly, it must not produce immunity. It will be readily recognized that it would be very difficult to pick out a disease which does not fail in one or more of these points.

The suggestion has been put forward that distemper might be utilized as a means of controlling the dingo pest, and it is therefore necessary to determine to what extent distemper will comply with the requisite conditions.

Distemper, as is well known, is probably the most serious complaint to which the dog population of this country is subject, although it might reasonably be argued that it is already so widespread in Australia that the effect of creating fresh centres of infection could be disregarded. Yet even in the case where a disease is widespread in a country, the suggestion to increase it further even in such manner as this cannot be entirely disregarded as not worthy of consideration, and if the disease were of such virulence and capable of such easy spread as would be necessary in dealing with the dingo, there must be created additional risk to the dogs in the country concerned.

Although distemper is a highly infectious disease, the probability of its spreading amongst animals leading the comparatively isolated life of the dingo and wild dog is extremely unlikely. It would be necessary to infect a large number of animals before any effects at all could be produced, and the work entailed in so doing would tend to approximate the work necessary for trapping the dingoes.

Even with so gregarious and numerous an animal as the rabbit, the problem of control by disease shows no encouraging aspects, and yet diseases are available for the work of a virulence not far below that of distemper. There must also be borne in mind the tendency of all wild animals to isolate themselves from their fellows and consequently to reduce the opportunities for infection.

On the question of producing immunity, the matter is not so clear, but unquestionably many dogs do survive an attack of distemper, and thereafter appear to be largely, if not altogether, immune. It is to be assumed that after a time some racial resistance would be developed in any susceptible breed amongst which the disease was introduced.

Taking the question as a whole, it does not appear to me that the suggestion to deal with the dingo pest by means of distemper holds out any reasonable hope of success. On the other hand, it seems that the dingo and wild dog menace can best be dealt with on the lines which, although expensive, have yet been found effective where rigidly enforced, that is to say, the erection and maintenance of dog-proof fences constructed over large areas of country on a concerted plan, and the utilization of the trap and poison bait within the fenced areas.

Irrigation of a Community Settlement.

By A. V. Lyon, M.Agr.Sc.

(Prepared October, 1927, as a basis for the work of the Advisory Irrigation Boards in the Murray Valley grape-producing settlements.)

The periods for irrigations in Australian community settlements are based almost solely on the principle of avoiding soil water shortages. As the period for one irrigation in the larger settlements is usually four and often five weeks, the early irrigators may receive water before the plants require it. This may be a hardship, particularly early in the season, by forcing growth, and producing the rank gross canes associated with difficult pruning, and in extreme cases with low yields.

These disadvantages are small compared with the heavy losses and injury to the plants, which result from delayed watering. For this reason, the dates of the irrigation periods should be so arranged that the late irrigators water before the plants suffer, entailing a start before the early irrigators actually need it.

Other important requirements that must be considered in arranging the seasonal irrigations are the necessity for securing an adequate soil water content for sprouting after the dormant period; avoidance of irrigation at the critical period covering flowering, setting, and cincturing; and a preharvest irrigation sufficiently late to enable the plants to carry through the harvest period, but not so late as to delay ripening, and deteriorate the quality of the fruit.

The Winter Irrigation.

A decision in respect to the necessity or otherwise of a winter irrigation should be delayed as long as possible. Winter rains, sufficient to render this irrigation unnecessary, and uneconomical, may occur. On the other hand, the irrigation, if given, should be completed about the end of August to ensure satisfactory sprouting of deciduous plants, which normally occurs early in September.

The Early Spring Irrigation.

In the majority of seasons, when winter rains are sufficient for the beginning of vine growth, the winter watering is omitted, and the first irrigation taken early in spring. It is not considered advisable to irrigate during flowering and setting, so this irrigation should be completed by the end of October, at which time flowering begins in the majority of seasons.

In seasons of regular spring rainfall the early spring irrigation may be omitted. In practice, it is only in exceptionally dry years, such as 1927, when a dry winter is followed by a dry spring, that both the winter and early spring irrigations are necessary. In the majority of seasons they are alternative, and in very wet years both may be omitted.

The Late Spring Irrigation.

This should be commenced immediately after setting, which is usually complete by 15th November. The plants, particularly vines, are growing vigorously and carrying a lot of foliage at this period, so the demands on the soil water are heavy. For this reason a delay in this, or the subsequent irrigation, is warranted only in seasons of exceptionally heavy rainfall.

The Mid-Summer Irrigation.

This irrigation should be commenced as soon as possible after that of late spring, with only such stoppage as is necessary for overhaul of machinery. The aim of all community irrigation settlements should be to distribute each irrigation within four weeks. With a stoppage of one week, the maximum period between irrigations of the late spring and midsummer is then five weeks. A longer period often results in disaster, by the occurrence of a spell of hot weather. The summer irrigation commences usually in late December or early January. The early irrigators need additional watering to maintain satisfactory conditions over harvest. Provision for this is made by continuing the summer irrigation until lands watered in late December and early January have received an additional "pre-harvest" irrigation.

Partial Irrigation of the Settlement.

This irrigation is for the purpose of nourishing deciduous plants until leaf fall and for the growth of cover crops. Its commencement is dependent on the completion of harvest operations, and usually takes place early in April.

Summary.

Approximate dates of Irrigation Periods.

Winter—1st August to 28th August.

Early Spring—3rd October to 31st October.

Late Spring—25th November to 23rd December.

Summer—1st January to 28th January, plus partial pre-harvest irrigation.

Special Autumn—20th February to 28th February.
1st April to 28th April.

It is recognized that minor alterations due to weather may be necessary. In the majority of seasons, when the winter and early spring irrigations are alternatives, four waterings result on the major portion of irrigated areas.

Additional waterings are given on certain areas that receive the mid-summer irrigation too early to carry over harvest; and for citrus and late grapes.

Scientific investigations will probably show that community irrigation has a fundamental fault, in that irrigation over the whole of the area in a limited time is not possible.

Investigations indicate that the fruiting habit of canes is associated with growth rates at critical periods. As growth is chiefly influenced by irrigation, modification of present practice may ultimately prove necessary.

In the meantime, it is advisable to conform to established practice, in conjunction with which a minimum of water and a maximum of cultivation give best results.

"Froggatt Collection" of Australian Insects.

An extensive reference collection is an indispensable adjunct to any organization engaged in entomological research. The formation of such a collection is a matter of time, diligent work in the field and laboratory, and of systematic acquisition of specimens by exchange or otherwise. By the purchase of the late Dr. E. W. Ferguson's collection of Coleoptera the Council has secured an exceptionally fine collection of Australian weevils. More recently the "Froggatt Collection," which was purchased by the Commonwealth Government from Mr. W. W. Froggatt, has been transferred to the Council. This collection was commenced about 35 years ago, and is now representative of nearly all the groups of Australian insects. Its value from a scientific point of view is greatly enhanced by the fact that it contains many types and authenticated specimens of species originally described by the author and by specialists abroad.

Division of Forest Products.

Ministerial authority has recently been obtained by the Council for the establishment of a Division of Forest Products. No great expenditure will be incurred at present in establishing a section to undertake strength tests. On the other hand, work will probably be undertaken on timber seasoning, timber preservation, and the utilization of wood waste and forest products generally. Mr. I. H. Boas, M.Sc., has been offered, and has accepted, the position of Chief of the Division. He commenced duty on the 2nd July. It had been intended that he would remain in Australia until September next, when the forthcoming meetings of the Imperial Forestry Conference are to be held, in order that he might discuss matters with Mr. Pearson, Director of the Forest Products Research Station at Princes Risborough, England, and with Mr. Winslow, Director of the Forest Products Laboratory, Madison, United States of America, both of whom it was thought might attend.

It has now been ascertained that neither Mr. Pearson nor Mr. Winslow is coming to Australia, and accordingly arrangements are being made for Mr. Boas to leave at once on a visit to Princes Risborough, and possibly the Continent. He will return home via America and the Madison Laboratory. It is expected that the whole visit will occupy his time until the middle of January next.

Catalogue of Scientific Periodicals.

In the first issue of this *Journal,* a brief mention was made (page 27) of the preparation of a catalogue of scientific and technical periodicals in Australian libraries, in order that the work of scientific investigators in the Commonwealth might be facilitated. It is, for instance, particularly useful in a country of such large distances for research workers to be able readily to ascertain which libraries contain particular periodicals they desire to see. Often such periodicals are comparatively rare in Australia.

Work on the compilation of the catalogue is proceeding, and it is expected that the publication will be complete in manuscript form shortly before the close of the year. It is difficult to estimate how long the printing will take as complications arise by reason of the necessity of using foreign letters and symbols in certain cases.

Entries have been received from 132 Australian libraries, and some 213 publishing societies and scientific institutions and departments have been approached for details of the publications they issue.

It is of interest to note that a similar catalogue has just been completed in the United States. Entries were received from 225 libraries, and the amount of work involved may be judged from the fact that about four years elapsed from the commencement of operations to the final appearance of the printed volumes.

Thirteenth International Physiological Congress.

The Thirteenth International Physiological Congress will meet at the Medical School of Harvard University, Boston, Massachusetts, 19th to 23rd August, 1929. The Federation of American Societies for Experimental Biology, which comprises the American Physiological Society, The American Society of Biological Chemists, The American Society for Experimental Pathology, and The American Society for Pharmacology and Experimental Therapeutics, will serve as hosts to the Congress, and Professor William Howell, of Johns Hopkins University, will be the President. The arrangements for the Congress are in charge of Professor Walter B. Cannon, of the Harvard Medical School, who is Chairman of the Congress Bureau, and Professors Edwin J. Cohn and Alfred C. Redfield, who are the secretaries.

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